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THE STUDY OF DRAGLINE OPERATION AT HIGHVALE MINE IN ALBERTA

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THE STUDY OF DRAGLINE OPERATION AT HIGHVALE MINE IN ALBERTA

by

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ABSTRACT

The dragline operation at the Highvale mine in Alberta was investigated as a part of a study of mining and operating practices at the mine.

The operating pratices of dragline operator observed at the mine are summarized. Modes of dragline operations practices at the mine during the study are evaluated and relationships between the mode of operation and productivity are highlighted.

Data collected from the operator's data files are examined and the summary of operational and delay times are summarized.

Time studies of the dragline operation and the values for cycle times for various dragline modes, bucket fill factors, effect of digging depth, swing angle and dump height on the elements of cycle time are evaluated. The real cycle times are established for both monitored draglines and the time of the shift. Graphs for cycle time variability and dragline cycle time histograms are presented.

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ÉTUDE DU FONCTIONNEMENT DES PELLES À BENNE TRAÎNANTE À LA MINE DE HIGHVALE EN ALBERTA

par

V. Srajer[1] et N.J. Stuart[2]

RÉSUMÉ

Le mode d'exploitation des pelles à benne traînante en vigueur à la mine Highvale en Alberta a été investigué dans le cadre d'une étude des méthodes d'exploitation et d'extraction minière en usage sur les lieux.

L'auteur présente un sommaire des méthodes d'exploitation des pelles à benne traînante telles qu'observées à la mine. Les modes d'exploitation des pelles à benne traînante observés dans le cadre de l'étude sont évalués et leurs incidences sur la productivité sont mises en évidence.

L'auteur présente une étude portant sur les données rassemblées à partir du fichier de données de l'opérateur ainsi qu'un sommaire relatif à la durée de fonctionnement et des retards.

Le facteur temps en ce qui concerne l'exploitation d'une pelle à benne traînante et les valeurs qui se rattachent aux temps de cycle des divers modes de la machine, les éléments qui entrent en jeu lors du remplissage des bennes, la profondeur de l'excavation, l'angle de rotation de la pelle excavatrice et la hauteur à partir de laquelle se fait le déchargement et les effets de ces facteurs sur les éléments d'information relatifs au temps de cycle sont évalués. Les temps de cycle des pelles à benne traînante contrôlées et les périodes de déphasage sont déterminés en temps reél. Le rapport comprend des tableaux indiquant les variations des cycles et des histogrammes décrivant les temps de cycle.

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INTRODUCTION

The time study of dragline operation at Highvale mine in Alberta was initiated in 1983 as part of a study of mining and operating practices at the mine. The study included monitoring of trucking and loading operation at the mine to prepare specification of equipment used at the mine and elsewhere for the new computer model of surface coal mines. This model is under development at the National Research Council in Ottawa and will eventually include various general modules of mining practices and mining equipments used at various surface coal mines in western Canada.

The presented study of dragline operation will be also useful to mine operator or mine planner, by giving them the summary and evaluation of cycle times data for various draglines, various shifts and different times of the shift.

DESCRIPTION OF FIELD WORK

During the period of July 1983 to February 1985, the Coal Research Laboratories conducted a study of the dragline operation at Highvale mine in Alberta. The purpose of the study was to obtain field data for the interactive computer model of dragline operation and also to evaluate dragline operating practices at the mine.

During July 1983 dragline operating cycles were monitored from outside of the cab using a stop-watch. The technician was stationed at the high wall of the pit, having a clear view of dragline movement. Two draglines were monitored: the Marion-8050 in Pit 03 and the BE-1360 in Pit 02-South. The purpose of this phase of the field study was to collect data on dragline movements such as digging, swinging, dumping and return, and to monitor and identify delay times, such as walking, cleaning around dragline by support equipment, coffee/lunch breaks, mechanical or electrical delays. The average working and delay times were calculated at each location. An attempt was also made to obtain averages for different time sections of the 12 hour shift to calculate changes in productivity due to operator's efficiency.

During the second field study period, in August 1984, dragline cycle times were recorded using a Polycorder (1). The recording technician was

stationed inside the dragline cabin. The two draglines were monitored again: the Marion-8050 in Pit 03 and the BE-1360 in Pit 02-South. The field work included monitoring during the day as well as night shift. Four 12 hour shifts were monitored for each cycle. The data obtained during this part of field work were transferred directly from Polycorder to the Calgary CRL VAX11/750 computer for further evaluation. The data transfer was completed immediately after each shift to eliminate any possibility of "losing" data while monitoring during the following shift. The data collected during the second field study were used for analysis in correlations between digging depth, swing angle, dumping height, swinging, dumping and return times, and for other statistical analysis described in the report.

During the third field study, in February 1985, a full cycle times were monitored for possible differences between summer and winter cycle times for both draglines. During this time, the dragline operators were also interviewed to obtain information on digging conditions, dragline performance and operating practices.

The field data in the final computer printout are in the Appendix. The first field study data were evaluated at the HP-45 microcomputer using "MPDA" software package and "STAT 1" package developed in-house. The second field study data were evaluated on the newly installed VAX-11/750 mini-computer using the in-house developed "CRUNCH" program. The third field work data were evaluated directly in the field using a linear regression package of the TI-55 calculator.

The remaining information, such as service records for both draglines, quantities of material moved and data on dragline's availability, efficiency and utilization were supplied by the engineers and technicians of TransAlta Utilities at the mine site and in at the head office in Calgary.

OPERATING PRACTICES

Both draglines under study operated in simple side-case mode, dumping overburden material on adjacent spoil. The thickness of the overburden was 10 to 20 metres in average whereas about 15 m average was recorded during the field work. On several occasions, the dragline was also positioned on a temporary lower bench, employing the chop-cutting method to

cast-up to 10 m of overburden on the spoil. The swing angle was measured between 75° and 180°.A dozer was sometimes used to the clean bench ahead of dragline or level the bench behind the dragline in preparation for walking. Tne same dozer was also used to pull dragline's electrical cable out during dragline walking. The specifications and geometry are discussed later in the text.

Both surveyed draglines appear to have similar operating controls. Each had three operating levers and two foot pedals. One lever was for swing, the second for drag, and the third for hoist. The foot pedal was used to operate the drag brake, the other was used for hoist brake.

The dragline is operated in the following way. For swinging the boom, the operator pulls the swing lever forward to swing one way, and backward to swing the other. The swing speed is controlled by the movement of the lever from the neutral position. The dragline swing is stopped by moving the lever to reverse the direction of swing, because the dragline does not have swing brakes.

At the beginning of the cycle, the bucket is lowered to initial digging position. The initial digging position should be the lowest position of the bucket for the cycle in order to maximize the digging and dragging forces. The operator, after returning the bucket to the digging position, uses the drag lever to pull the bucket in toward the fairlead. During this time, he maintains some tension in the hoist cable by using the hoist brake intermittently.

Digging is started by moving the drag level forward. In easy digging, the operator uses full drag speed. In hard digging, the operator reduces dragging speed, applying the hoist brake to keep tension in the hoist cable. If enough tension is not maintained, the bucket will bury itself and stall. If too much tension is maintained, the bucket will come out of the bank too early, only partially filled.

When the operator see that bucket is full, he hoists the bucket by putting the drag lever in neutral and apply full hoist speed. At the same time, he starts the swing. During hoisting the bucket, the operator uses the drag brake to maintain tension in the drag cable, thereby preventing the bucket from dumping. The swing speed is controlled and maintained to coordinate the hoist speed. When the bucket reaches the dumping position, the operator returns the hoist lever to neutral, engage the drag motor. When

the bucket is emptied the return swing begins. During the dumping, the bucket usually hangs about 5 m above the spoil. The boom is returned to the digging position by the operator using the drag lever to pull the bucket. It was observed on several occasions, the operator is positioning the bucket in the bank during the bucket return, maintaining drag speed so that the bucket enters the bank digging. This was the case during shallow digging.

There are several factors that effect the cycle time of the dragline:

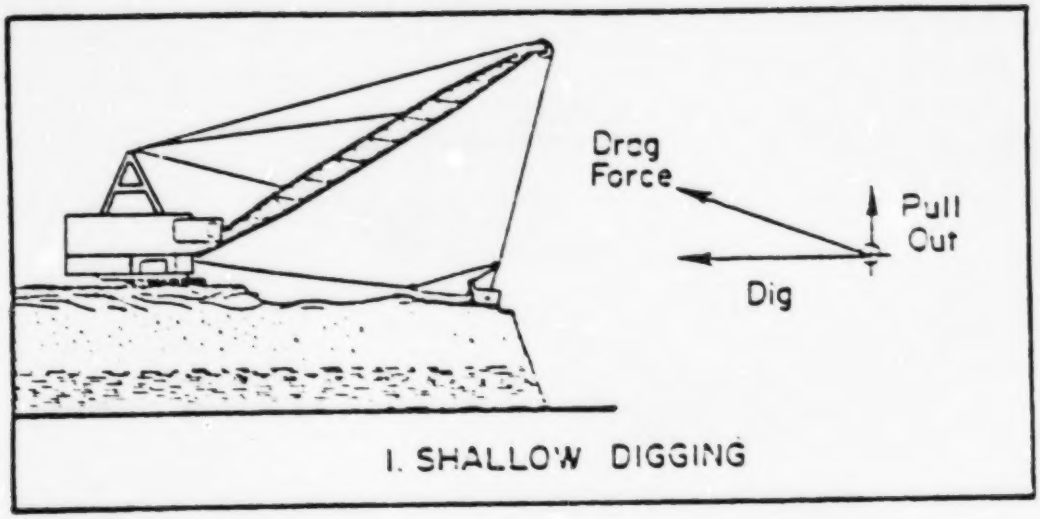
1. Digging Depth. The digging time will increase with increasing depth. This is, because, at shallow depth, the horizontal component of the drag force is larger than the vertical component of the force. This tends to keep the bucket in the bank. With increasing depth the vertical component increases. The vertical component always tends to pull the bucket out of the bank. This changing force vectors slow the digging as the depth increases (Fig. 1).

2. Double Digging. The bucket is partially unfilled during first pass, is lifted and lowered again for the second pass. This is also called multi-pass digging. It is assumed, that double digging would double the digging time.

3. Block Length. Exceptionally long blocks directly increase the digging time (Fig. 2). For a block of normal length, the bucket is directly under the boom point when digging begins. The bucket is filled at about 1/2 to 2/3 of the way to the fairlead and therefore can be hoisted without spillage. On the contrary, for a long block, the bucket is cast beyond the boom point at its deepest position. The bucket will therefore be too far from the fairlead when filled and cannot be hoisted without tipping and losing some of the load. Thus the operator is forced to drag the full bucket in toward the fairlead before hoisting. This increases the digging time.

4. Type of overburden. Sandstone or any hard rock in the overburden, will increase digging time. Digging of sandstone and limestone takes about 4 to 8 seconds more in one cycle than digging shale or any other soft material.

5. Operator Efficiency. An unexperienced operator works much slower, reduce bucket fill factor, or spill material on the way to the spoil pile. Subsequent double digging, cleaning around the dragline, or lost of coal by covering the seam from extended spoil, increase digging time and reduce



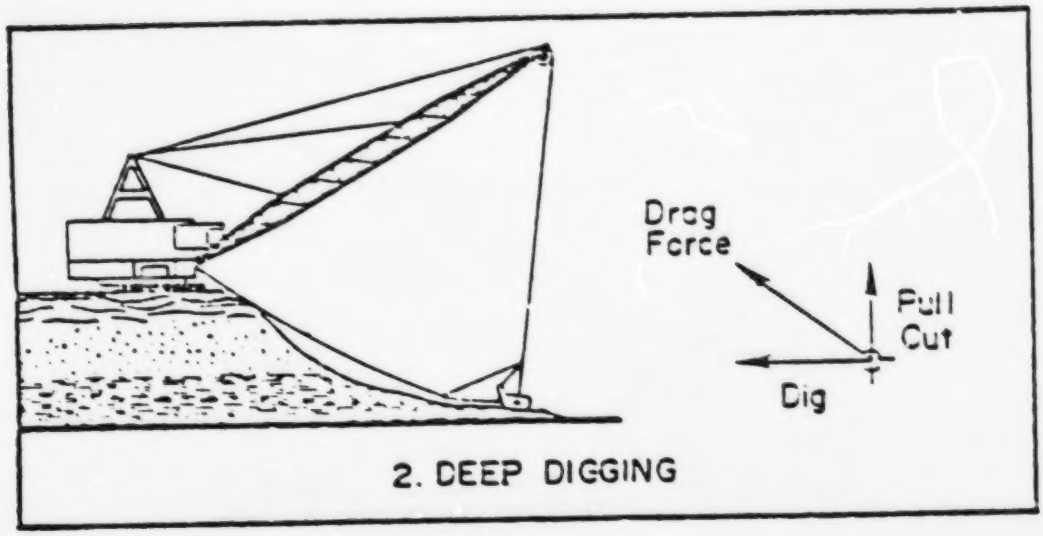


Fig. 1 - The effect of digging depth on drag force (2)

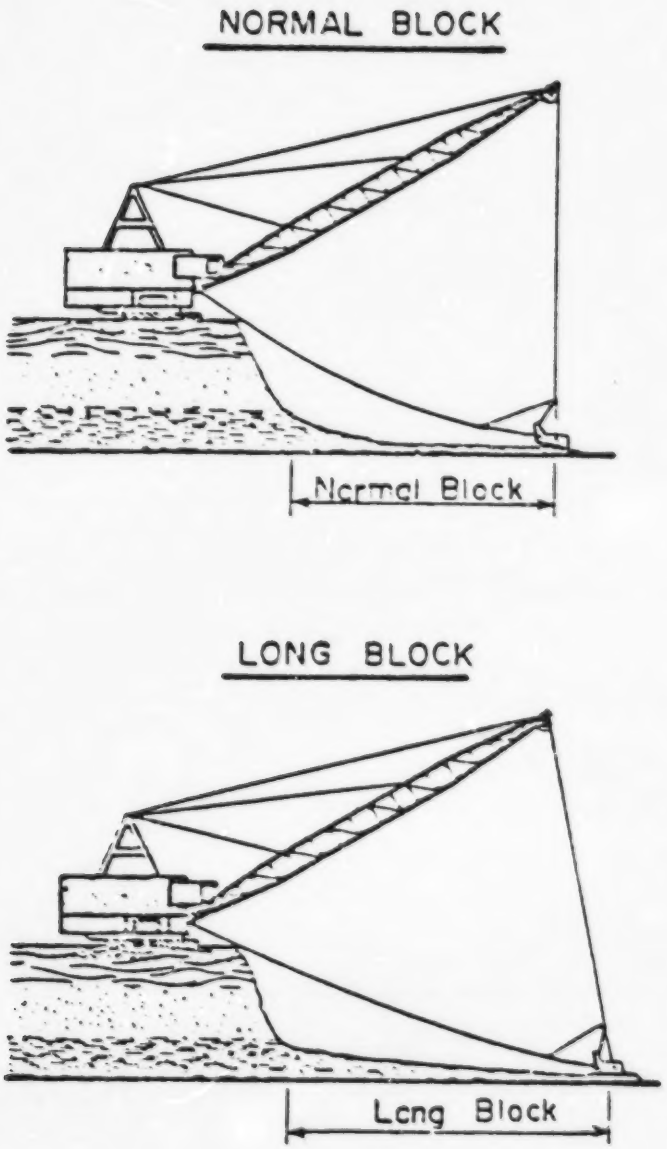


Fig. 2 - The effect of block length on bucket position (2)

productivity. The operator's inability to position the bucket for digging also increases cycle time by several seconds.

6. Digging Methods. Maximum efficiency is achieved when digging a normal size block and with simple side casting. A delay in digging time is caused when chopping above tub level, during box cut digging and rehandle. When digging a box-cut at the beginning of a block, the bucket is positioned in a narrow slot and this increases filling time. The digging time becomesalmost double when this material is rehandled.

7. Bucket Fill Factors. The bucket fill factor was estimated to be over 80%. Several times the bucket fill factors were lower than normal, such as: during chop-cut - when the range was 50-70% only, during hard digging - about 5-10% lower, and during near new highwall digging - 10-15% lower.

8. Increased Swing Angle. The swing time increases with increasing swing angle.

9. Spoil Pile Height. The high of spoil pile directly increases swing and positioning time and therefore increases the cycle time.

10. Dump Time. The dump time increases when the dragline is positioned closer to the spoil pile. The operator reduces swing speed and increase hoist speed, therefore increasing swing time and consequently dump time. At the Marion dragline the hoist speed could be increased by 300 rpm by pressing a button, therefore dump time is reduced when compared to other draglines.

11. Others. In this category, the walking, clean-up, delay (mechanical or electrical), shift changes or other work delatys are included. They have an overall effect on the effective cycle time by increasing average time needed to move a unit weight of material. Stoppage due to poor weather is also included here. Reduction in dragline performance, due to bad weather was not observed at Highvale mine. It is recognized, that heavy snow fall could increase overall cycle time, because the snow is loaded and dumped onto spoil, adding weight and reducing the stability of the spoil pile. A heavy rain could deterioriate surface of the bench, increase possibility of high-wall collapse and add weight to digged material. A fog will reduce visibility and consequently reduce operator's efficiency. A frost will harden material and increase the digging time. Consequent thawing of frozen material during spring reduces the spoil pile stability. A change in bucket fill factor was not observed during summer and winter as was expected. Some

buckets were not fully loaded in winter up chunks of frozen material, were loaded that effectively overfill the bucket. It is assumed, that frozen and unfrozen material did not increase or decrease bucket fill factor significantly.

TIME STUDIES DATA

FIRST FIELD WORK

First field data were collected during July 1983. The following variables were identified in the calculation:

DAT: digging above tub level
DBT: digging below tub level
S<90: swing less than 90° - bucket full
S>90: swing over 90° - bucket full
Dump: dump time
Return: return time - bucket empty
Other: any unidentified delay
Coffee: stoppage for coffee and lunch
Clean: dozer cleaning around dragline
Walking: dragline walking to new position

The cycle time averages were calculated daily, for each monitored dragline. A total average working time for 12 hr shift was calculated and total working and delay times were identified.

An average working time for 12 hour period at both draglines was 7.028 hrs. A total working time monitored during study period (July 4-8) was five working shift or 84376 seconds. A total delay time recorded during study was 47519 seconds.

Table 1 summarizes data sets as listed for each day and identify data sets for different part of the shift. The data sets are listed at two tapes (No. 1 and 2) for evaluation at HP-45 computer. The number of data sets for delay times are also listed in Table 1.

Table 1 - List of data sets

Tape	Date	No. of data sets	No. of data sets (operation)			No. of data sets (delays)			
			(7-11)	(11-15)	(15-19)	walk	clean	coffee	other
1	Jul 4	118	-	-	-	1	1	1	6
	Jul 5	253	119-188	189-277	278-371	1	10	4	2
	Jul 6	229	372-427	428-532	533-599	0	4	4	6
2	Jul 7	113	-	-	1-113	1	2	1	2
	Jul 8	333	114-282	283-446	-	0	0	3	2
	TOTAL					3	17	13	18

The following tables summarize the operational and delay times (in sec) as follows:

Table 2 - Operational/delay times averages - BE-1360 dragline (Pit 02)

Date		Operational							Delay		
		DAT	DBT	S 90	S 90	Dump	Ret	Other	Coffee	Clean	Walk
Jul 4	#	19	99	31	87	118	109	6	1	1	1
	val	16.89	21.32	12.23	25.45	6.06	25.07	197.00	672.00	151.00	401.00
Jul 7	#	109	4	58	55	113	108	2	1	2	1
	val	22.29	19.25	12.59	18.58	6.59	28.66	15418.50	626.00	651.50	997.00
Jul 8	#	333	0	333	0	333	326	2	3	0	0
	val	21.86	0	16.03	0	6.81	25.45	403.00	1454.33	0	0
TOTAL	#	461	103	422	142	564	543	10	5	3	2
AVE	val	22.45	21.24	15.28	22.79	6.61	26.01	7908.05	1132.20	484.67	699.00

Table 3 - Operational/delay times averages - Marion 8050 dragline (Pit 03)

Date		Operational							Delay		
		DAT	DBT	S<90	S>90	Dump	Ret	Other	Coffee	Clean	Walk
Jul 5	#	333	13	52	201	253	243	3	4	10	1
	val	26.03	58.62	15.81	22.90	7.30	32.61	1735.00	1608.00	437.50	1384.00
Jul 6	#	222	6	15	213	227	215	7	4	4	0
	val	22.09	21.17	17.13	32.45	5.37	42.69	2309.29	884.25	864.25	0
TOTAL	#	455	19	67	414	480	458	10	8	14	1
AVE	val	22.11	46.79	16.11	27.81	6.39	37.34	2137.00	1246.12	559.43	1384.00

Table 4 - Operational/delay times averages - BE-1360 and Marion 8050

Drag-line		Operational							Delay		
		DAT	DBT	S<90	S>90	Dump	Ret	Other	Coffee	Clean	Walk
BE-1360	#	461	103	422	142	564	543	10	5	3	2
	val	22.45	21.24	15.28	22.79	6.61	26.01	7908.05	1132.20	484.67	699.00
Marion	#	455	19	67	414	480	458	10	8	14	1
	val	24.11	46.79	16.11	27.81	6.39	37.34	2137.00	1246.12	559.43	1384.00
TOTAL	#	916	122	489	556	1044	1001	20	13	17	3
AVE	val	23.27	25.22	15.39	26.53	6.51	31.19	5022.52	1202.30	546.24	927.33

The data from Tables 2 and 4 leads to the followincg conclusions:

1. Dragline BE-1360:
   - Digging above tub (chop-cut) was 5.6% slower than digging below the tub.
   - Swing time increased 49.1% for the swing over 90° compared to swing under 90°.
   - A total cycle time averages are

     (for) DAT and S<90: 70.35 sec

     DAT and S>90: 77.86 sec

     DBT and S<90: 69.14 sec

     DBT and S>90: 76.65 sec

2. Dragline Marion-8050:

- Digging above tub (chop-cut) was 94.1% faster than the digging below tub. This was due to the fact that the above tub digging was in rehandle material.
- Swing time increased 72.6% for the swing over 90° as compared to swing under 90°.
- A total cycle time averages are

(for) DAT and S<90: 83.95 sec
DAT and S>90: 95.65 sec
DBT and S<90: 106.63 sec
DBT and S>90: 118.33 sec.

Overall, dragline BE-1360 was productive than Marion-8050 in the following cycles:

DAT and S<90: 19.3%
DAT and S>90: 22.8%
DBT and S<90: 54.2%
DBT and S>90: 54.4%.

The averages for both draglines indicate the following cycle times:

DAT and S<90: 76.36 sec
DAT and S>90: 87.50 sec
DBT and S<90: 78.31 sec
DBT and S>90: 89.45 sec.

The difference between the best case (digging rehandle material above tub level and less than 90° swing) and worst case (digging below tub level but swinging over 90°)is 17.1%.

The values for cycle time obtained during monitoring of the 12 hours shift (July 5,6,7) were also evaluated and differences in cycle times for first, second and third period of the working shift were recorded. Tables 5-7 summarize values for cycle time and for the time periods 7:00-11:00, 11:00-15:00 and 15:00-19:00. The day shift was monitored at this time only. The "number" in this Table represents the number of occurrences of cycles monitored, "value" in this Table is an average time in seconds for part

Table 5 - Summary of cycle times (7:00-11:00 hrs)

Date		Operational							Delay		
		DAT	DBT	S<90	S>90	Dump	Ret	Other	Coffee	Clean	Walk
Jul 5	#	169	0	169	0	169	166	1	2	0	0
	val	22.07	0	15.41	0	7.17	24.08	131.00	1713.50	0	0
Jul 6	#	57	13	2	68	70	66	2	1	0	0
	val	29.28	58.62	20.00	25.25	6.97	38.48	2246.50	2228.00	0	0
Jul 7	#	50	6	7	49	55	51	5	1	0	0
	val	20.68	21.17	24.43	34.12	6.53	42.67	2831.00	167.00	0	0
TOTAL	#	276	19	178	117	294	283	8	4	0	0
AVE	val	23.31	46.79	15.81	28.97	7.00	30.79	2347.37	1455.50	0	0

Table 6 - Summary of cycle times (11:00-15:00 hrs)

Date		Operational							Delay		
		DAT	DBT	S<90	S>90	Dump	Ret	Other	Coffee	Clean	Walk
Jul 5	#	164	0	164	0	164	160	1	1	0	0
	val	21.65	0	16.68	0	6.44	26.88	675.00	936.00	0	0
Jul 6	#	87	0	31	58	89	85	0	2	4	1
	val	23.28	0	14.71	23.21	7.49	32.36	0	1740.00	246.75	1384.00
Jul 7	#	105	0	0	105	105	100	1	1	3	0
		23.53	0	0	33.15	5.11	45.46	203.00	828.00	408.00	0
TOTAL	#	356	0	195	163	358	345	2	4	7	1
AVE	val	22.60	0	16.36	29.61	6.32	33.62	439.00	1311.00	315.86	1384.00

Table 7 - Summary of cycle times (15:00-19:00 hrs)

Date		Operational							Delay		
		DAT	DBT	S<90	S>90	Dump	Ret	Other	Coffee	Clean	Walk
Jul 5	#	109	4	58	55	113	108	2	1	2	1
	val	22.29	19.25	12.59	18.58	6.59	28.66	15418.50	626.00	651.50	997.00
Jul 6	#	89	0	19	75	94	92	1	1	6	0
	val	26.63	0	17.16	20.55	7.35	28.62	712.00	724.00	564.67	0
Jul 7	#	67	0	8	59	67	64	1	2	1	0
	val	20.87	0	10.75	29.80	4.84	38.38	1807.00	1271.00	2233.00	0
TOTAL	#	265	4	85	189	274	264	4	4	9	1
AVE	val	23.39	19.25	13.44	22.86	6.42	31.00	8339.00	973.00	769.33	997.00

An averages for each time period of working shift are summarized in Table 8 (operational times) and Table 9 (delay times).

Table 8 - An averages for each time period of shift - operational times

Cycle (sec)	Shift period		
	(7:00-11:00)	(11:00-15:00)	(15:00-19:00)
DAT	23.31	22.60	23.39
DBT	46.79	0	19.25
S<90	15.81	16.36	13.44
S>90	28.97	29.61	22.86
Dump	7.00	6.32	6.42
Ret	30.79	33.62	31.00

Table 9 - An averages for each time period of shift - delay times

Delay (sec)	Shift period (sec)		
	(7:00-11:00)	(11:00-15:00)	(15:00-19:00)
Other	2347.38	439.00	8339.00
Coffee	1445.50	1311.00	973.00
Clean	0	315.86	769.33
Walk	0	1384.00	997.00
TOTAL	3802.88	3449.86	11078.33

element of the cycle monitored. The "null" values indicate that dragline was not used during monitored period to perform this portion of the cycle.

In conclusion, the productivity of dragline operation and operating efficiency changes during shift.

The cycle time for digging above tub improved during second third of the shift by 3.1% and was about the same by the end of the shift. No sufficient data are available to evaluate the digging below tub level. The swing time (for S 90) increased by 3.5% by middle of the shift but decreased full 21.7% by the end of the shift. The swing time (for S 90) increased 2.2% by the middle of the shift and decreased 29.5% by the end of the shift. The dumping times decreased 10.7% during second third of the shift and slightly increased (1.6%) by the end of the shift. The return times shown similar trend. It increased 9.2% during the second third and decreased 8.4% during the last third of the shift.

The overall cycle times are summarized in Table 10.

Table 10 - Overall cycle times for each time period of the shift

Cycle (sec)	Shift period (sec)		
	(7:00-11:00)	(11:00-15:00)	(15:00-19:00)
DAT/S<90	76.91	78.90	74.25
DAT/S>90	90.07	92.15	83.67
DBT/S<90	100.39	-	70.11
DBT/S>90	113.55	-	79.53

Iy comparing values in Table 10, the following variances were observed and are attributed to the time of shift:

1. The cycle time for digging above the tub level and less than 90° swing,increased 2.6% during the second third shift and decreased 6.3% by the end of shift.
2. The cycle time for digging above tub level and less than 90° swing increased 2.3% during the second third of the shift and decreased 10.1% last third of the shift.
3. The cycle time for digging below the tub level and less than 90° swing decrease 43.2% by the end of the shift. No sufficient data are available for the second third of the shift.

4. The cycle time for digging below the tub level and having over 90° swing angle decrease 42.8% by the end of the shift. No below tub digging was observed during second third of the shift.

The above conclusions represent some of the significant changes that are directly related to the operating efficiency during working shift. There is a significant improvement in productivity during the last third of the shift and a decrease in productivity during the second third of the shift. The trend is so obvious that should not be ignored.

The computer printout and listing of data on file used to evaluate and analyse this data are enclosed in the Appendix "A", pages 1-32. The data on file "HMDL:T14" were used in this evaluation. The mean values were obtained using in-house developed program "STAT 1" that is tied-up onto the "MPDA" package.

SECOND DATA COLLECTION

During August 1984, dragline cycle times were recorded using Polycorder and data were evaluated on VAX-11/750 computer.

The values were recorded by the technician stationed inside dragline cabin. The technician recorded the time of beginning of each activity and also identified bucket depth (-20, -15, -10, -5, 0, 5, 10, 15 metres), bucket swing (75, 90, 105, 120, 135, 150, 165, 180 degrees) and height of dump (5, 10, 15, 20, 25, 30, 35, 40 metres). The elevations are relative to the tub level, swing angle is the actual swing angle of the bucket from digging to dumping activity.

The recorded values were analysed and are summarized for two draglines: BE-1360 and Marion-8050, for day and night shifts separately. The in-house developed program "Crunch" was used to analyse the data.

The following tables (Tables 11-22) represents summary of basic statistics. In the tables, "class of data" means depth or height in 5 metre intervals and swing angle in 15° intervals. The standard deviation of values are also included in this statistical overview.

Table 11 - The effect of digging depth (BE-1360: day shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
-20	-	-	-	-	-	-	-	-	-	-	-	-
-15	7	26.11	9.77	7	17.30	1.76	7	6.23	1.93	7	20.60	3.20
-10	12	22.55	5.47	12	19.34	3.62	12	4.27	1.67	12	21.45	3.98
- 5	3	13.99	3.55	3	27.29	5.79	3	6.52	0.75	3	34.41	1.04
0	316	19.70	9.16	316	24.51	5.31	316	4.96	1.51	316	26.05	5.99
5	135	17.25	6.76	135	26.95	4.49	135	5.34	1.55	135	26.83	4.83
10	17	16.68	4.14	17	25.98	3.85	17	5.21	0.97	17	26.59	4.96
15	-	-	-	-	-	-	-	-	-	-	-	-

Table 12 - The effect of digging depth (BE-1360: night shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
-20	-	-	-	-	-	-	-	-	-	-	-	-
-15	-	-	-	-	-	-	-	-	-	-	-	-
-10	-	-	-	-	-	-	-	-	-	-	-	-
- 5	-	-	-	-	-	-	-	-	-	-	-	-
0	148	19.89	8.61	148	25.78	1.91	148	3.86	1.17	148	30.52	2.46
5	94	16.82	5.38	94	24.81	1.99	94	3.74	1.03	94	29.58	3.00
10	6	17.12	4.57	6	26.19	1.72	6	3.07	0.54	6	31.65	2.63
15	-	-	-	-	-	-	-	-	-	-	-	-

Table 13 - The effect of digging depth (Marion 8050: day shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
-20	-	-	-	-	-	-	-	-	-	-	-	-
-15	-	-	-	-	-	-	-	-	-	-	-	-
-10	41	22.35	7.75	41	24.32	5.85	41	4.98	1.18	41	22.43	7.25
- 5	108	19.65	8.42	108	19.95	5.09	108	4.77	1.19	108	17.33	6.39
0	95	19.27	10.41	95	19.04	3.99	95	4.71	1.86	95	17.08	5.34
5	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-

Table 14 - The effect of digging depth (Marion 8050: night shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
-20	-	-	-	-	-	-	-	-	-	-	-	-
-15	2	26.69	11.31	2	18.75	1.17	2	4.30	0	2	18.14	1.10
-10	108	18.93	4.57	108	18.71	2.88	108	3.90	1.04	108	17.54	3.46
- 5	113	21.97	8.69	113	18.71	3.29	113	4.60	1.31	113	17.39	4.32
0	71	22.91	15.48	71	20.75	10.20	71	4.95	1.76	71	20.48	11.92
5	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-

Table 15 - The effect of swing angle (BE-1360: day shift)

Class (deg.)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
180	35	16.31	5.50	35	29.74	4.74	35	5.78	1.46	35	33.81	2.98
165	7	18.71	4.31	7	28.59	3.15	7	4.88	1.22	7	33.26	2.08
150	41	18.71	6.36	41	25.38	4.10	41	4.95	1.50	41	25.80	3.56
135	118	18.53	6.95	118	24.48	3.38	118	4.88	1.53	118	24.95	4.05
120	74	20.86	10.51	74	22.17	3.26	74	5.06	1.81	74	23.98	4.33
105	53	14.96	7.90	53	21.95	4.78	53	4.90	1.46	53	22.62	3.16
90	44	20.25	10.64	44	19.32	2.35	44	4.88	1.24	44	20.43	2.61
75	18	21.74	8.16	18	16.69	2.97	18	4.95	1.60	18	19.15	3.28

Table 16 - The effect of swing angle (BE-1360: night shift)

Class (deg.)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
180	66	16.87	6.38	66	25.58	1.55	66	3.39	0.92	66	30.83	2.54
165	61	17.30	8.34	61	24.47	1.63	61	3.86	0.99	61	29.49	2.44
180	45	17.88	6.60	45	24.08	1.38	45	3.65	1.24	45	28.45	2.76
135	8	19.59	4.25	8	23.77	1.26	8	3.06	1.03	8	27.16	1.39
120	-	-	-	-	-	-	-	-	-	-	-	-
105	-	-	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-

Table 17 - The effect of swing angle (Marion-8050: day shift)

Class (deg.)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
180	8	13.73	4.13	8	25.29	2.34	8	5.53	0.89	8	23.03	1.87
165	3	16.19	3.25	3	21.91	0.50	3	4.37	2.49	3	20.49	4.00
150	-	-	-	-	-	-	-	-	-	-	-	-
135	-	-	-	-	-	-	-	-	-	-	-	-
120	18	21.30	8.89	18	19.05	1.64	18	4.95	1.29	18	15.64	4.23
105	18	21.81	8.72	18	17.31	4.23	18	4.45	0.85	18	13.91	2.41
90	107	21.28	10.40	107	18.41	1.83	107	4.47	0.95	107	15.25	2.41
75	43	15.19	5.54	43	16.11	1.52	43	4.88	1.10	43	14.80	3.89

Table 18 - The effect of swing angle (Marion-8050: night shift)

Class (deg.)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
180	-	-	-	-	-	-	-	-	-	-	-	-
165	-	-	-	-	-	-	-	-	-	-	-	-
150	-	-	-	-	-	-	-	-	-	-	-	-
135	7	20.91	3.92	7	26.03	2.80	7	2.53	0.41	7	25.07	6.26
120	19	18.89	5.00	19	21.87	1.57	19	3.58	1.19	19	22.19	2.94
105	32	15.25	4.99	32	21.14	1.72	32	3.50	0.71	32	20.27	2.87
90	94	20.62	7.47	94	18.20	2.45	94	4.12	1.12	94	16.68	3.17
75	31	22.04	9.13	31	18.02	2.18	31	4.14	1.06	31	17.53	3.00

Table 19 - The effect of dump height (BE-1360: day shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
5	35	25.11	7.30	35	21.52	4.20	35	4.52	1.71	35	22.66	3.72
10	164	17.39	6.74	164	22.78	4.20	164	5.11	1.51	164	23.90	4.34
15	251	19.30	9.37	251	25.70	5.12	251	4.98	1.50	251	27.03	5.74
20	40	18.91	7.30	40	29.63	4.68	40	5.96	1.28	40	32.83	4.61
25	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-

Table 20 - The effect of dump height (BE-1360: night shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
5	-	-	-	-	-	-	-	-	-	-	-	-
10	111	18.26	7.78	111	25.06	1.69	111	3.57	1.05	111	30.34	2.68
15	76	18.65	7.21	76	25.25	2.04	76	3.76	1.03	76	30.11	2.72
20	61	19.40	7.79	61	26.29	2.19	61	4.24	1.22	61	30.01	2.81
25	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-

Table 21 - The effect of dump height (Marion-8050: day shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
5	8	27.44	15.28	8	31.82	3.14	8	6.25	1.90	8	31.26	5.13
10	29	17.30	5.50	29	27.34	3.94	29	5.59	2.82	29	26.52	4.58
15	21	20.48	5.96	21	26.14	4.72	21	4.81	1.42	21	26.71	5.30
20	184	20.05	9.51	184	18.12	2.76	184	4.58	1.05	184	15.28	3.48
25	2	13.82	3.10	2	15.64	1.10	2	5.60	0.05	2	11.65	0.60
30	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-

Table 22 - The effect of dump height (Marion-8050: night shift)

Class (m)	Time (sec)											
	Dig			Swing			Dump			Return		
	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.	No.	Val.	Dev.
5	23	32.13	22.55	23	15.96	3.69	23	5.93	2.19	23	15.48	4.99
10	18	24.71	8.40	18	19.72	10.73	18	6.25	1.35	18	17.47	12.01
15	64	20.40	6.48	64	19.86	9.30	64	4.87	0.84	64	18.90	11.08
20	118	20.75	7.30	118	17.73	2.11	118	4.19	1.09	118	16.57	2.88
25	71	17.87	6.98	71	21.98	2.07	71	3.46	0.92	71	21.32	3.56
30	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-

The dragline BE-1360 was monitored 67 560 seconds during the day shift and 42 600 seconds during the night shift. The productive times were recorded and amounted to 36 750 seconds during the day shift and 19 360.83 seconds during the night shift. This represents 54.40% productive time for day shift and 45.45% for night shift. The dragline Marion-8050 was monitored 32 040 seconds during the day shift and 31 920 seconds during the night shift. The productive non-delay time recorded was 15 410.98 seconds during day shift and 18 504.08 seconds during the night shift. This again represents 48.10% productive time for the day shift and 57.97% for the night shift. Table 23 summarizes the mean cycle times and deviations for both draglines.

Table 23 - Mean cycle time summary

Dragline	Shift	Mean cycle time (sec)	Deviation
BE-1360	Day	75.00	12.91
	Night	78.07	9.61
Marion 8050	Day	63.16	14.85
	Night	62.94	14.33

The cycle times for Marion-8050 were recorded 18.75% shorter during day shift and 24.04% during night shift than cycle times for BE-1360 dragline. The cycle times of BE-1360 dragline were only 4.09% longer during night shift and were about the same for Marion 8050 dragline.

THIRD DATA COLLECTION

The third data collection were undertaken during the period of February 18-28, 1985. The purpose of the study was to establish possible differences between the summer and winter cycle times. Only full cycle times were monitored. The temperature ranged from -4°C to -12°C, averaged -7°C. Day shift data were collected and only BE-1360 dragline was monitored. The dragline was observed in Pit 02-S working between ramps 6 and 7. The following Table 24 summarizes real cycle times for three ranges of the swing angle: 60°-90°, 90°-120° and 120°-150°. The dragline was in simple side-casting mode, digging below the tub level. The operators visibility was very good, some light snow was falling on several occasions.

Table 24 - Winter survey cycle time summary

Statistics	Swing angle		
	60°-90°	90°-120°	120°-150°
Mean	94.18	100.48	111.36
Standard deviation	73.41	11.08	23.05
No. of cycles	125	40	22

The mean cycle times increased with large swing angle as expected. The increase from 90° to 120° was 6.7%, from 120° to 150° was 10.8%. The cycle time increase was 30.06% when the cycle times surveyed during the summer are compared with the cycle times surveyed in the winter for the same dragline working in the same pit. The mean weighted averages of cycle times were 97.55 seconds during winter survey, compared to 75.00 seconds during the summer survey. This number is quite significant and conclusive. The reason for an increase in cycle times in winter is obvious - harder digging conditions and therefore slower machine movement. The walking times of dragline were also investigated during this survey. The mean time averages for each dragline's step was calculated at 60.5 seconds for 2.75 m step resulting in average walking speed of 164 metres per hour. There were no measureable differences recorded in changes of swing time for dragline turning clockwise or anti-clockwise.

DATA ANALYSIS

BUCKET FILL FACTORS

During the field studies in 1984 the mean cycle times were established. These times were used in the calculation of number of cycles by dividing total operating times by the mean cycle time averages. This calculation was completed for each dragline and for each day monitored. By using available production data (total amount of the material moved) and the number of cycles, the average bucket load was calculated. The average bucket load increased 25% (3) to accommodate swell of overburden material. The calcuated bucket fill factor is somewhat lower than anticipated. This was due to the fact, that both draglines were monitored for some time during chop-cut mode and also because of the reporting practice at the Highvale mine to include "walking time" into "total operating time". The presented bucket fill factor is therefore average bucket fill factor for the total dragline operating period.

The summaries of the average cycle times and bucket fill factors for each dragline are shown in Tables 25 and 26.

Table 25 - Bucket fill factors: BE-1360 dragline

Date	Shift	Oper. time (min)	Ave. cycle time (sec)	No. of cycles	Production (bm^3)	Bucket load (bm^3)	Bucket fill factor
Jul 30	D	835	75.00	668	15 375	23.02	0.75
Aug 02	D	955	75.00	764	15 290	20.01	0.65
Aug 03	D	1115	75.00	892	17 852	20.01	0.65
Aug 09	N	395	78.07	304	6 324	20.80	0.68
Aug 10	N	1130	78.07	868	18 092	20.84	0.68
AVERAGE							0.68

Table 26 - Bucket fill factors: Marion 8050 dragline

Date	Shift	Oper. time (min)	Ave. cycle time (sec)	No. of cycles	Production (bm^3)	Bucket load (bm^3)	Bucket fill factor
Jul 31	D	905	63.16	860	17 550	20.41	0.58
Aug 01	D	580	63.16	551	10 062	18.26	0.52
Aug 07	N	545	62.94	520	9 455	18.18	0.51
Aug 08	N	920	62.94	877	15 960	18.20	0.51
AVERAGE							0.53

The standard bucket size of 38.20 m^3 was used for BE-1360 dragline and 44.30 m^3 was used for the Marion-8050 dragline. The average bucket fill factor for BE-1360 dragline was calculated to be 0.68 and for Marion 8050 dragline 0.53.

CYCLE TIME VARIABILITY

The Effect of Digging Depth

Two graphs are presented to show the relationship between the elements of cycle time (dig-swing-dump-return) and various digging depths. The first graph (Fig. 3) is for BE-1360 dragline, second graph (Fig. 4) is for the Marion-8050 dragline.

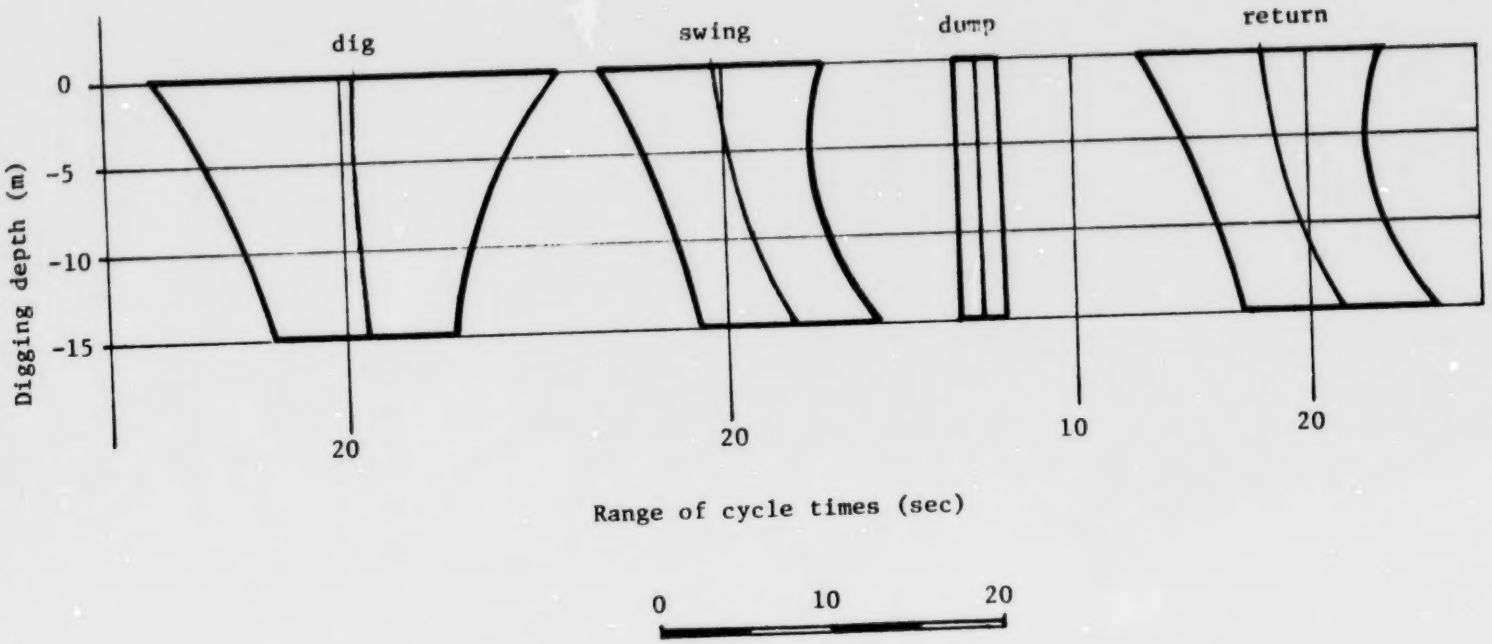


Fig. 3 - The effect of digging depth (Marion-8050)

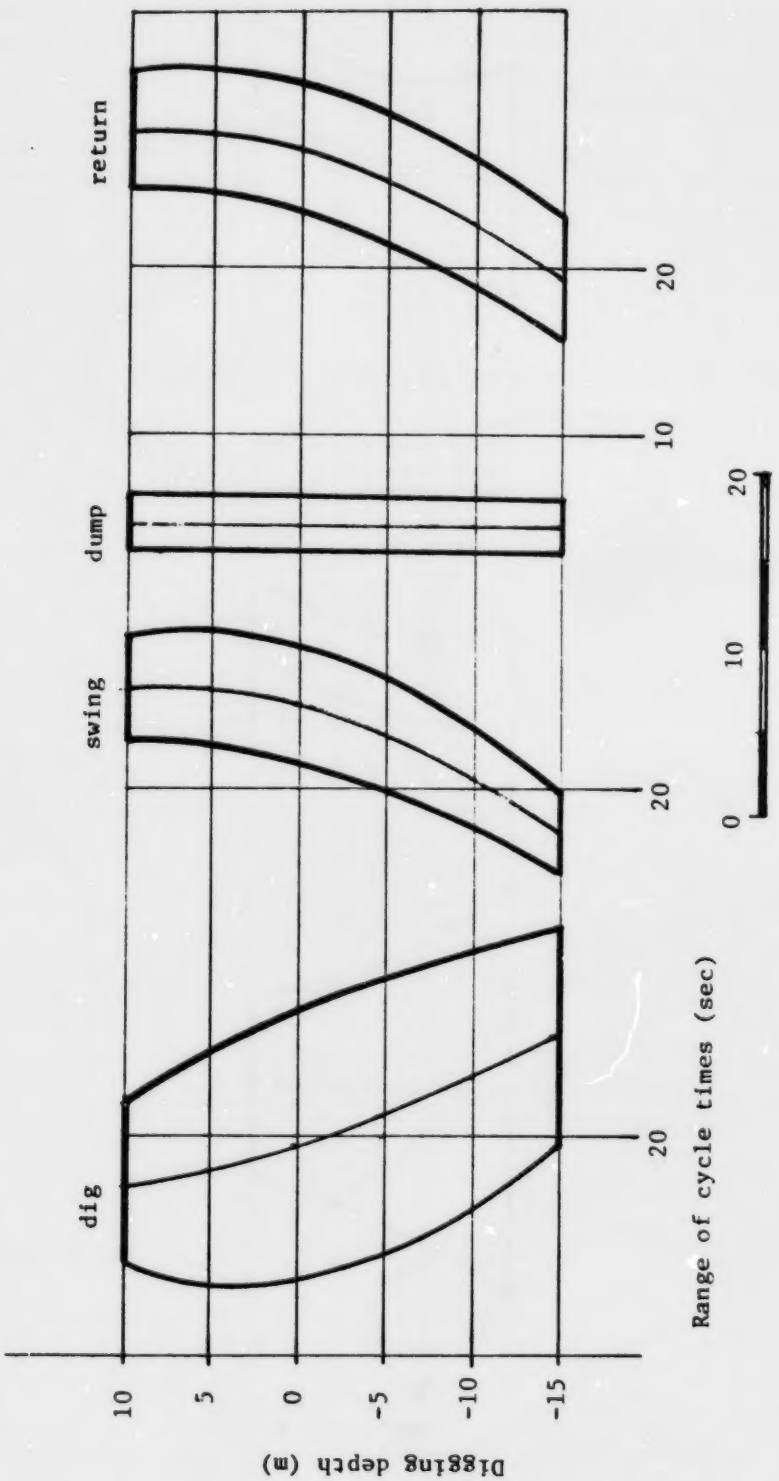


Fig. 4 - The effect of digging depth (BE-1360)

The cycle times were plotted against the digging depth with the deviations calculated for each variable. The times were approximated and the extreme values with insignificant number of occurrences were eliminated. The result is a diagram of cycle times with range of values of each cycle element.

Figure 3 illustrates that the BE-1360 dragline is digging faster in "chop-cut" mode than in "below-the-tub" cutting mode. The swing time was higher in "chop-cut" mode, so the return time. There was no change in dump times in any event or during any occasion. The Marion-8050 dragline behaved differently (Fig. 4). This dragline was not monitored during the "chop-cut" mode, because it digged in "below-the-tub" mode only during the survey. It is concluded that there is no significant increase in digging times at deeper pit, but swing and return times are increasing with the increase digging depth.

The Effect of Swing Angle

Two graphs are presented to show the effect of swing angle on the cycle time elements. Figure 5 illustrates the range of variances for BE-1360 dragline and Figure 6 for Marion 8050 dragline.

Both figures have similar pattern. The digging time is highest for swing angles between 105 to 135 degrees. The swing and return times are lower for smaller swing angles, but not in linear relationship to each other. The swing and return times are almost identical for angles below 90° for Marion-8050 dragline, but lower for BE-1360 dragline. The return times for BE-1360 dragline are significantly higher when compared to Marion-8050 dragline.

The Effect of Dump Height

The effect of dump height on cycle elements times is presented Fig. 7 for dragline BE-1360 and on Fig. 8 for dragline Marion 8050. By comparison both graphs the difference between the range of cycle times and dump height for both draglines become apparent. The digging times are lower for dump height of 10-15 metres for BE-1360 dragline, but higher for dump height of 15-20 metres for Marion 8050 dragline. The swing time is decreasing with lower dump height for BE-160 dragline but increasing for Marion-8050 dragline. The return times shown similar pattern.

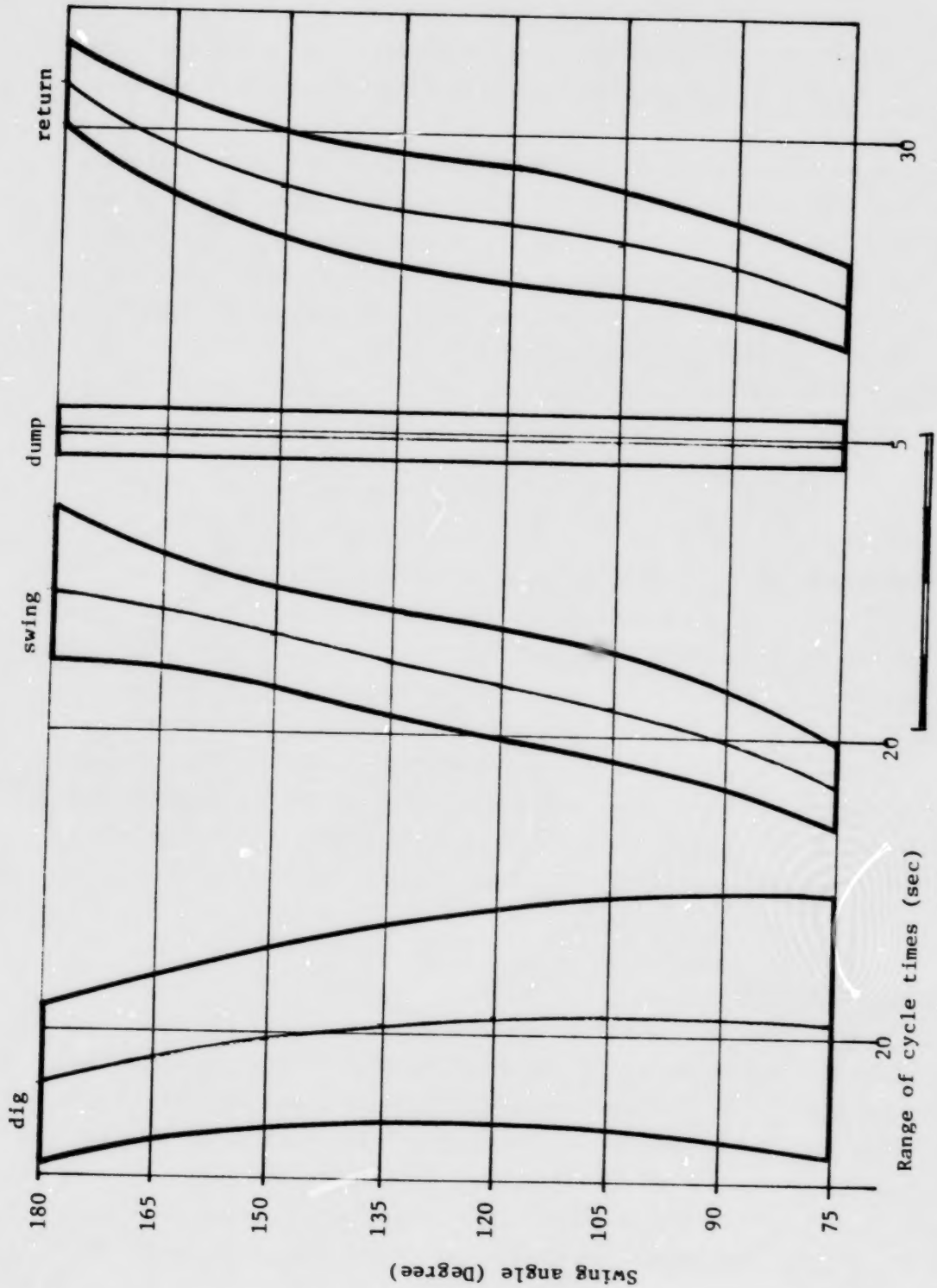


Fig. 5 - The effect of swing angle (BE-1360)

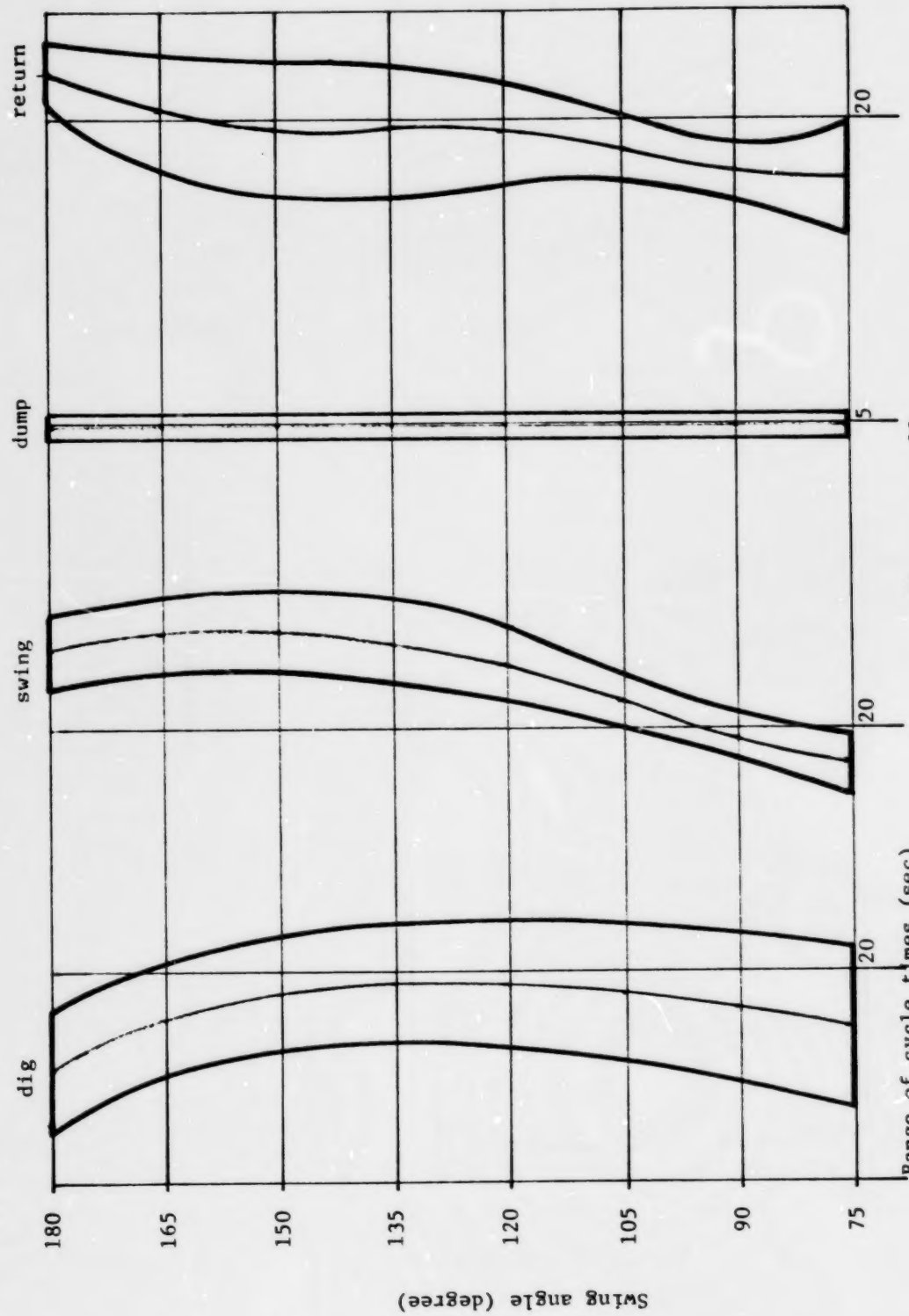


Fig. 6 - The effect of swing angle (Marion-8050)

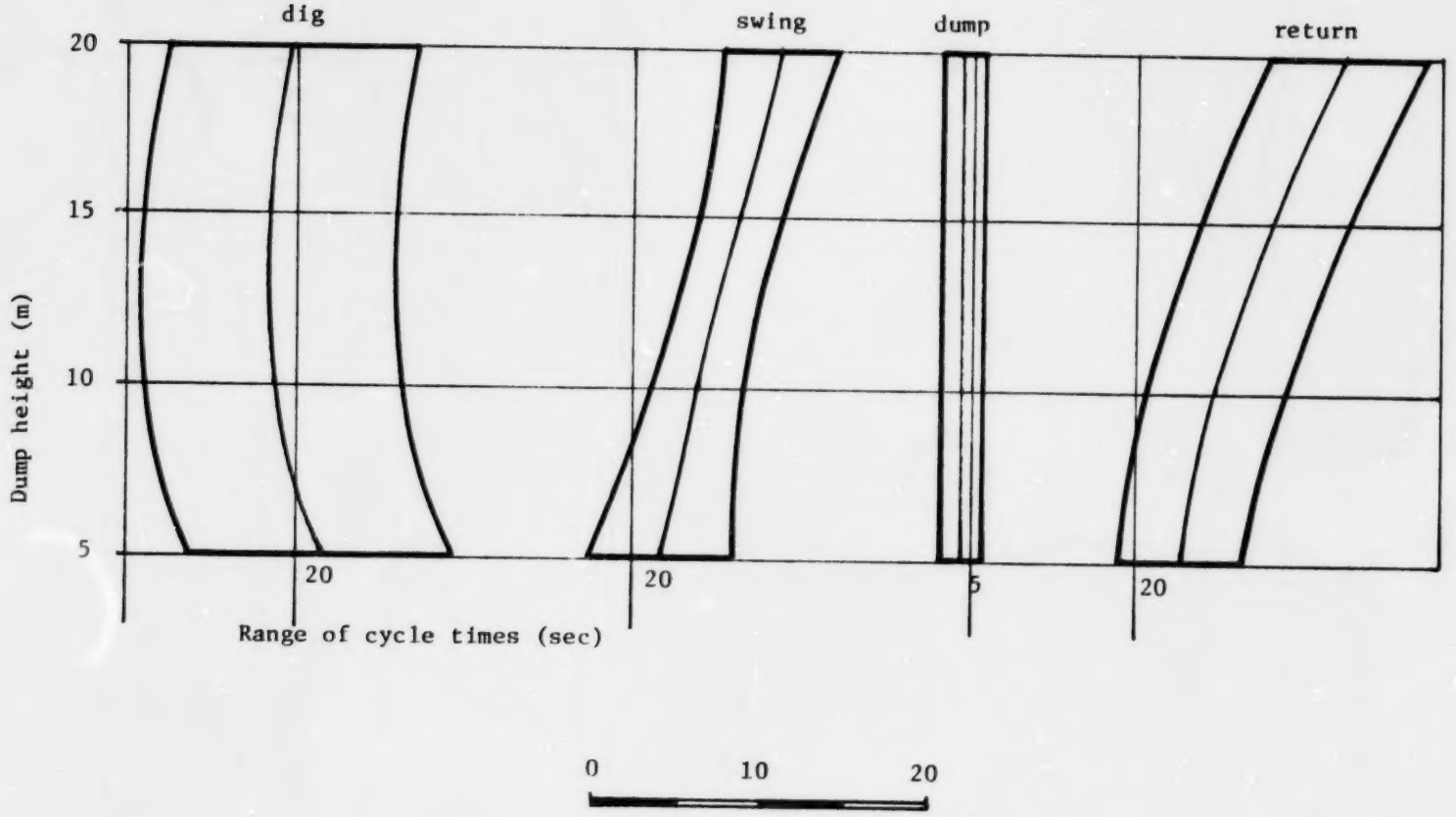


Fig. 7 - The effect of dump height (BE-1360)

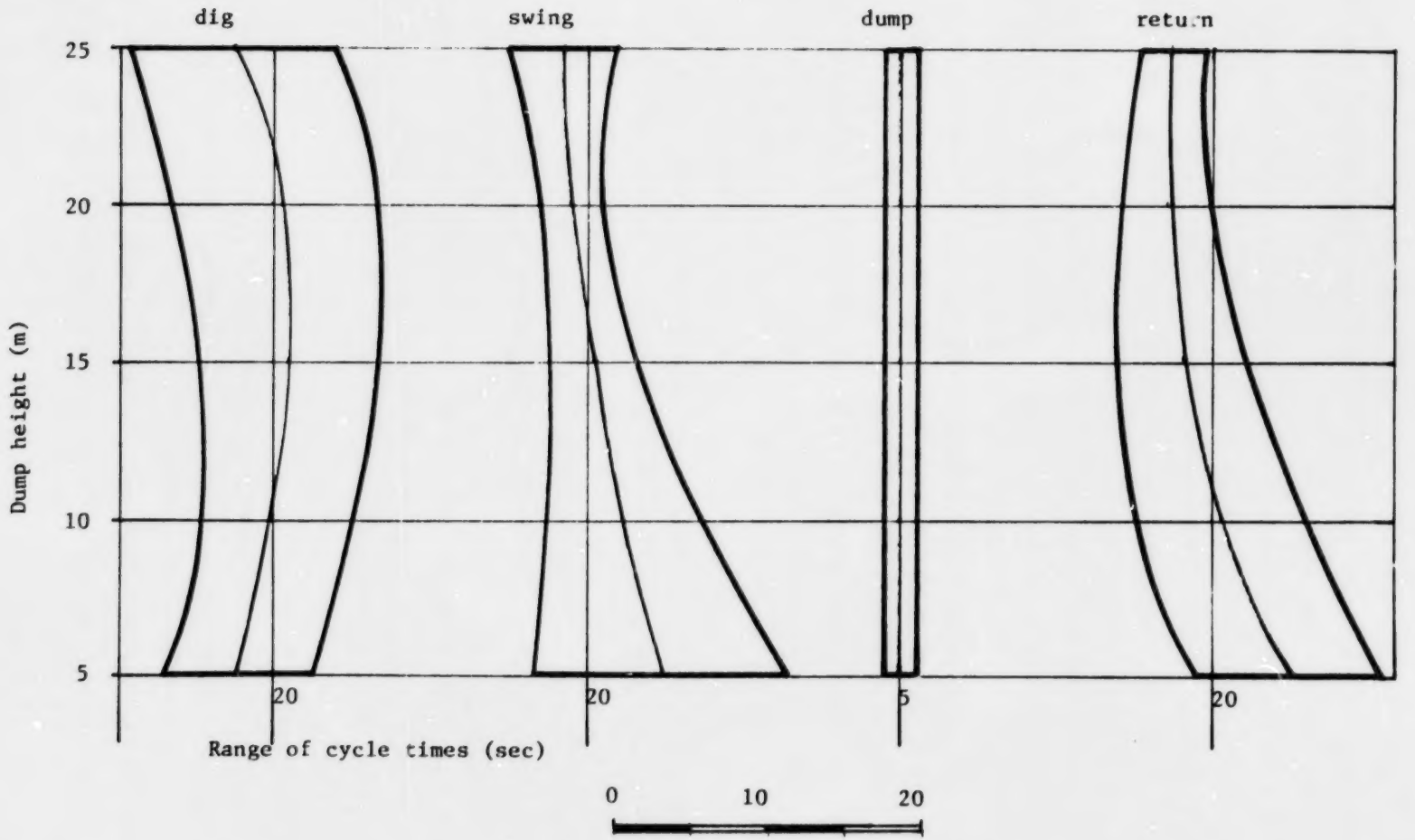


Fig. 8 - The effect of dump height (Marion-8050)

Logically, it wasexpected, that both draglines will behave similarly. This was not the case during the field observation and presented analysis of data support that statement.

The diagrams in Figures 1-6 could be used to determine range of cycle times for elements of the cycle and its variability when compared to the digging depth, swing angle and dump height. No direct relationship exist between these variables that could be proved by field investigation. There are so many additional variables affecting the elements of the cycle that same logical trend was not identified. One of the significant variables having an effect on cycle times was handling of the machine by the operator. Some operators are overfilling bucket during digging, therefore increasing digging time, some are commencing dumping during the swinging of the bucket. Some operators are more experienced than the others, having shorter times for the cycle. The characteristics of the material to be dug and the reach of the dragline are other factors effecting cycle times. Some of these variables are not identifiable in the field and certainly the use and monitoring of all these variables will prove cumbersome and not verypractical.

To overcome some problems in the similar work in the future, it is recommended to include the following additional elements of the cycle:

1. Bucket Positioning. There was time loss occasions when dragline operator completed the return of the bucket but did not start digging. Also a "slow-down" of the bucket, or "swinging" of the bucket before commencement of the digging may be included here.
2. Drag After Fill. On several occasions, the operator kept dragging the bucket even after it had been completely filled, therefore increasing digging time and also the cleaning time around the dragline by dropping spoil material during the return cycle.

CYCLE TIME HISTOGRAMS

The cycle times of draglines vary considerably. There were recorded variations between two monitored draglines, between day and night shift and also between different times of the day.

Four histograms were developed, showing average cycle times for two draglines. The first two histograms (Figs. 9 and 10) are for BE-1360

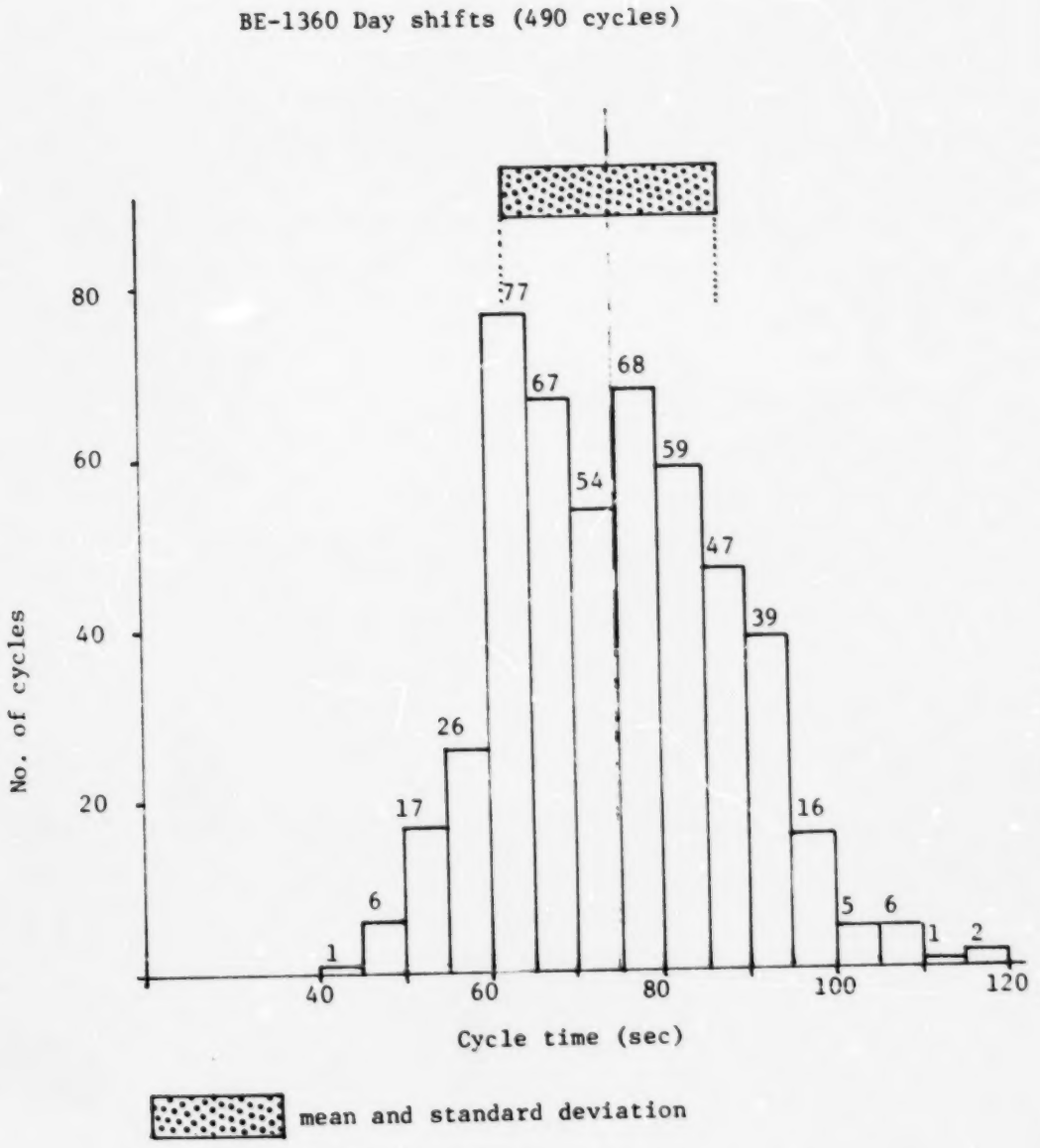


Fig. 9 - Dragline cycle time histogram : CD-1360

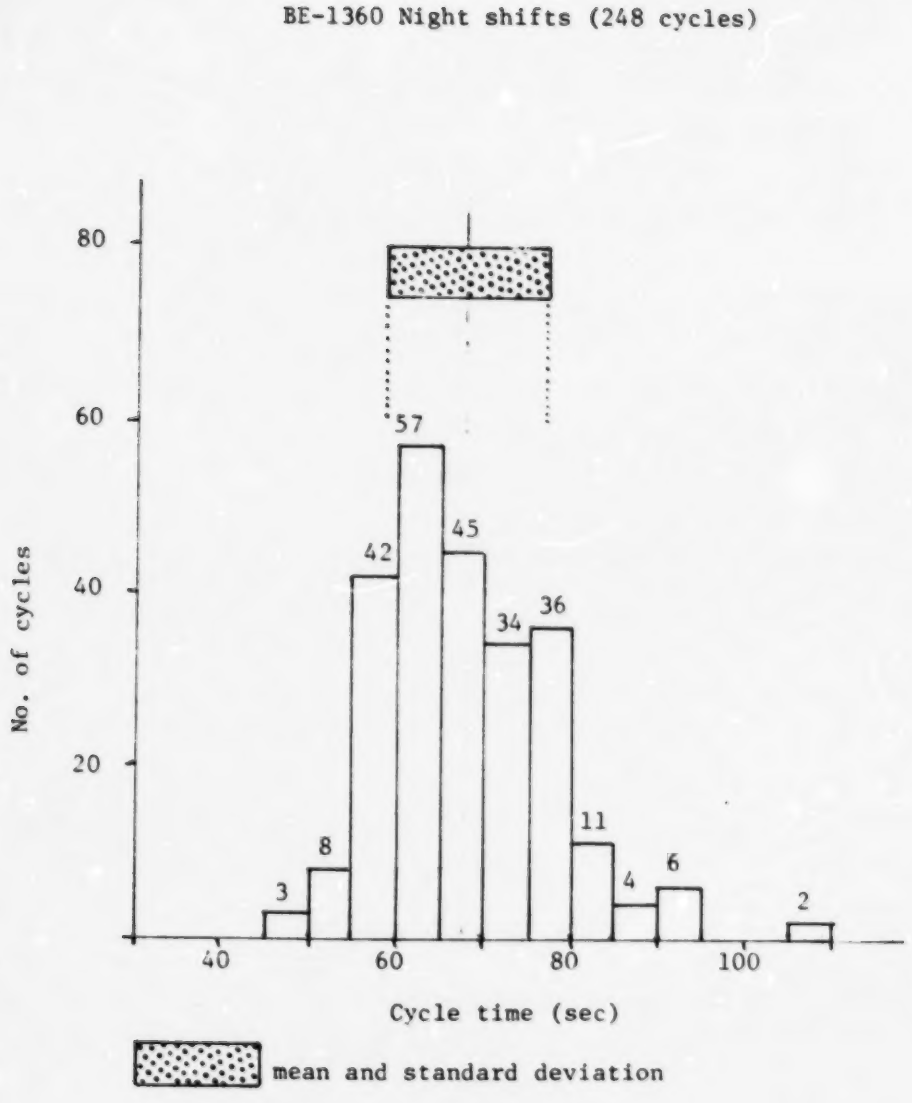


Fig. 10 - Dragline cycle time histogram: CN-1360

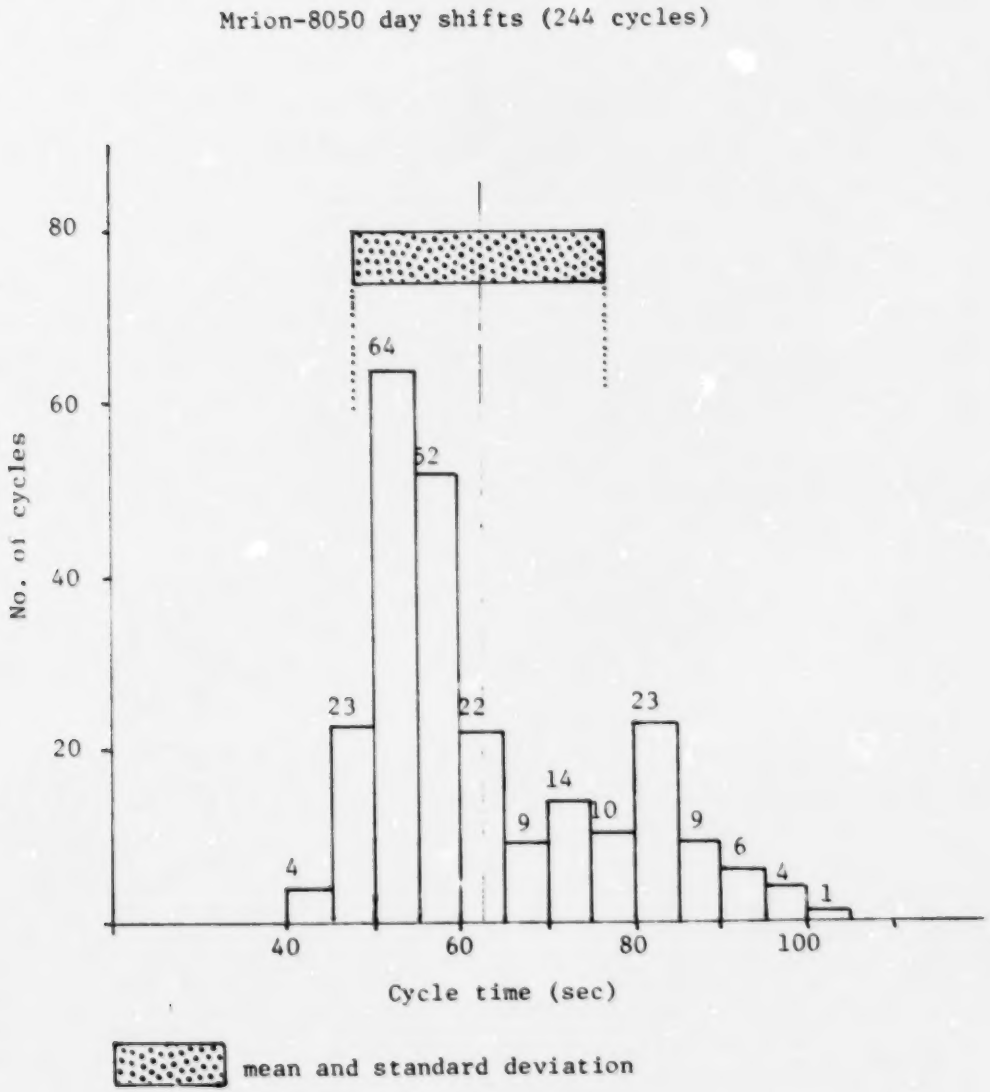


Fig. 11 - Dragline cycle time histogram: CD-8050

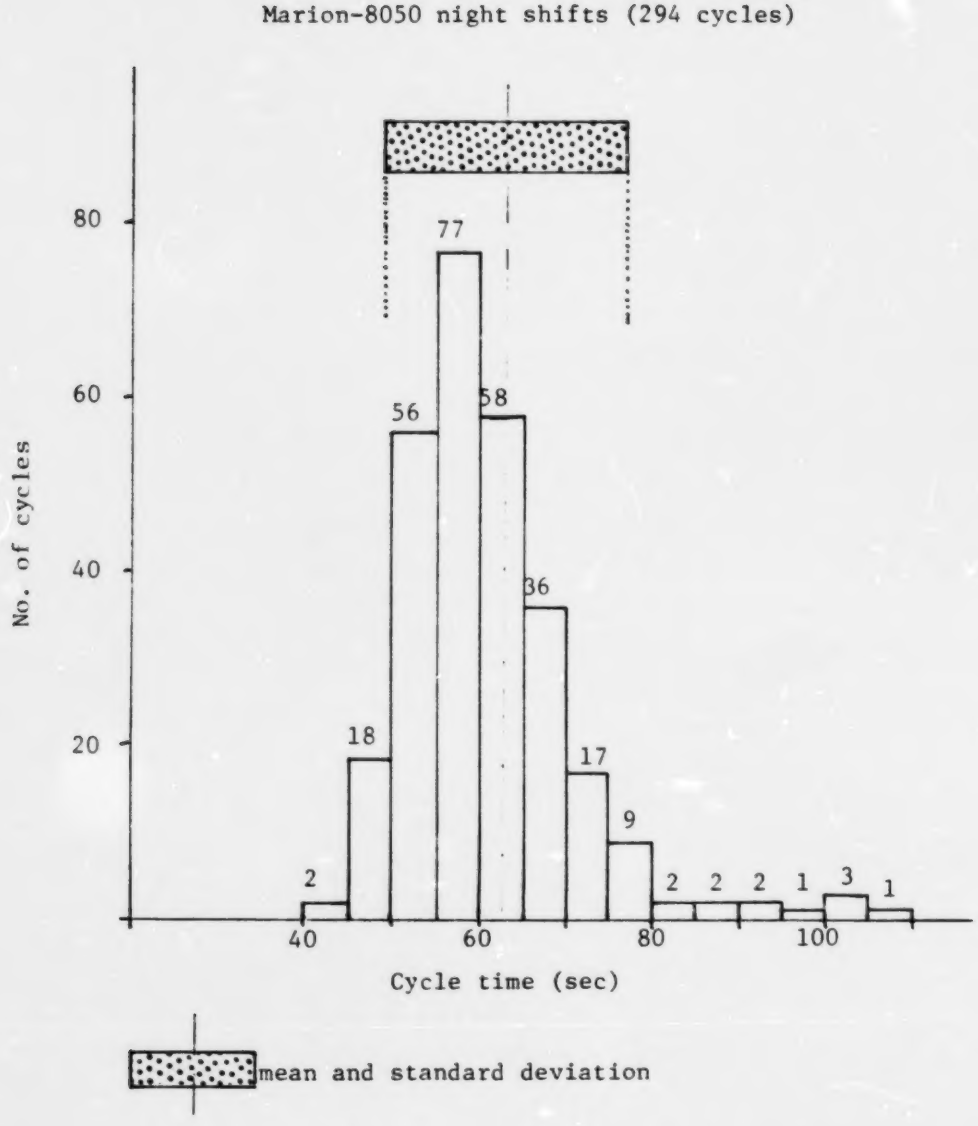


Fig. 12 - Dragline cycle time histogram: CN-8050

dragline (day and night shifts). Third and fourth histograms (Figs. 11 and 12) are for the Marion-8050 dragline (day and night shifts). The data for all histograms were sorted using the following data basis:

1. CD.1360.DAT and CN.1360.DAT were used for histograms of BE-1360 dragline.
2. CD.8050.DAT and CN.8050.DAT were used for histograms of Marion 8050 dragline.

The data files are stored in [POLY] directory of the VAX-11/750 computer. The printout of the original data files is enclosed in Apppendix "B" (pages 33-39) of this report. The printout of the classification of data used for development of histograms are in Appendix "C" (pages 40-43).

The mean value averages of cycle times calculated with standard deviation are also shown on all histograms. These values contains 63% of all cycle times data for dragline BE-1360 (day shift), 70% of data for dragline BE-1360 (night shift), 73% of data for dragline Marion-8050 (day shift) and 83% of all data for dragline Marion-8050 (night shift).

CONCLUSION

The report on dragline operation at Highvale mine in Alberta includes time study of dragline cycle times from July 1983 to February 1985. Two draglines were monitored: BE-1360 in Pit 02-S and Marion-8050 in Pit 03.

Firstly, the study summarizes the operating practices observed at the mine and used to control the dragline operation. The variances having effects on cycle times are discussed. The variances are: digging depth, double digging, various block length, type of overburden, operations efficiency, digging method, bucket fill factor, increased swing angle, spoil pile height, dump time and so on.

Secondly, the field study data collected in July 1983, August 1984 and February 1985 are summarized.

During the first survey period, a total of 7.028 hours were recorded to be an average dragline working time during the 12 hours period. It was also concluded that in "chop-cut" mode the digging was 5.6% slower than digging "below-the-tub" for BE-1360 dragline but much faster for Marion-8050 dragline. The swing time increased 49.1% for the swing angles over 90° at

BE-1360 dragline and 72.6% at Marion-8050 dragline. A cycle time range for BE-1360 dragline was 69 to 78 seconds; 83 to 119 seconds for Marion-8050 dragline.

The summary of cycle times for digging above and below-the-tub level, for swing angle below and over 90°, times for dumping and return elements of the cycle are tabulated. The summary of cycle elements for various times of the shift are also presented. The productivity of the dragline operator changes during the shift, so his operating efficiency.

During the second field survey period, elements of the dragline cycle were recorded using "Polycorder". The data were collected during day and night shift and evaluated on VAX-11/750 minicomputer. The effect of digging depth, swing angle and dump height was evaluated and is discussed in the report. Several diagrams showing relationship between the cycle times, digging depth, swing angle and dump height are presented and analysed. The real cycle time for this survey was in range of 75 to 78 seconds for BE-1360 dragline and close to 63 seconds for Marion-8050 dragline.

The third data collection were taken during winter 1985 to establish correlation for the cycle times during the cold weather. The real weighted averages of cycle times during the winter were measured to be 97.55 seconds or 30% higher than during summer survey. By using the same field data and production quantities supplied by mine operators, the bucket fill factor was calculated. The factor for BE-1360 dragline was established to be 0.68; for Marion-8050 dragline 0.53.

The cycle time histograms are also presented for each monitored dragline and for both day and night shifts. Over 63% of all cycle times for BE-1360 and over 73% for Marion-8050 dragline are within standard deviation range.

ACKNOWLEDGEMENT

The authors are indebted to the mining operation and engineering staff of TransAlta Utilities Ltd. in Calgary and Manalta Coal Ltd. at the Highvale mine site for the opportunity to study and monitor their mining operation, for their advice and help during the field survey and during the evaluation of the data.

The authors also would like to thank to W. Lidkea of the University of Alberta and P. Guyn of the University of Calgary, both working as summer students with the Coal Research Laboratories in Calgary for their help during field work and data evaluation.

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2. Mathtech, Inc. "Operating guidelines for dragline stripping systems"; Contract No. U.S.D.O.E. ET-77-C-01-9110; 1979.

3. TransAlta Utilities: Personal communication; 1985.

APPENDIX A: FIRST FIELD WORK DATA

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
1		25	11		9
2	10	16	10		6
3	9	33	15		5
4	19	11	14		6
5	18	7	18		6
6	26	5		16	6
7	79	6		19	6
8	19	15		16	6
9	18	11		17	3
10	17	29		14	8
11	25	33		17	7
12	4	305	10		6
13	13		10		8
14	43		11		7
15	42		10		4
16	17	132		12	5
17	12	8	13		5
18	17	10	14		5
19	22	10	20		5
20	16	32	16		5
21	17	58	12		5
22	54	44			8
23		227	8		7
24	25	36	12		8
25	23	15	11	151	6
26		13			6
27		15	11		6
		305			
	15	17	12		6
	13	21	7		6

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
28		17	12		6
	19				
29		12	10		7
		72			
30	17			25	5
	22				
31	16			26	4
	23				
32	15			22	3
	25				
33	11			26	3
	24				
34	12			26	4
	24				
35	11			22	6
	25				
36	25			12	9
	32				
37		11		26	26
		51			
38		10	12		7
	13				
39		21	13		8
	12				
40		16	12		7
	13				
41		38	10		7
	14				
42		21	10		6
	15				
43		18	11		6
	17				
44		60	9		6
	14				
45		24	11		6
	35				
46	15			25	6
	24				
47	12			24	7
	23				
48	20			24	7
	26				
49	7			28	6
			672		
50	15			21	8
	23				
51	14			27	7
	24				
52	13			24	7
	23				
53	17			22	6
	27				
54		44		25	9
	27				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
55		19		24	5
56	26	16		22	8
57	25	16		20	7
58	26	12		22	9
59	22	13		21	8
60	25	17		26	5
61	25	10		27	5
62	29	14		26	6
63	33	14		29	5
64	27	15		45	7
65	24	16		25	6
66	26	14		21	7
67	25	18		26	5
68	26	13		25	23
69	31	16		26	8
70	27	16		29	5
71	54	19		26	6
72	24	15		21	5
73	22	20		23	6
74	24	18		20	6
75	24	15		27	5
76	28	24		26	5
77	25	16		25	6
78	19	19		25	401 6
79	26	13		28	6
80	22	34		25	4
81	25	21		29	8
	22				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
82	26	20		27	5
83	25	23		25	6
84	30	11		25	6
85	24	18		28	7
86	25	15		25	6
87	24	20		27	5
88	25	26		26	6
89	26	22		25	5
90	25	18		27	4
91	25	22		27	5
92	25	23		27	7
93	25	28		29	6
94	25	27	24		8
95	29	13		26	4
96	26	12		28	5
97	38	40		27	5
98	24	18		29	6
99	31	15		27	4
100	35	25		30	3
101	29	22		31	5
102	29	15		27	4
103	29	14		26	6
104	30	12		27	4
105	29	17		29	5
106	30	12		28	4
107	29	20		29	3
108	26	21		25	3

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
109		17		27	6
	29				
110		25		53	5
	26				
111		34		29	4
	28				
112		91		29	4
	28				
113		17		28	3
	29				
114		17		39	4
	26				
115		30		24	4
	38				
116		71		25	5
	27				
117		29		24	4
	29				
118		30		24	4
119		86		16	9
		326			
120		17		21	9
	22				
121		14		22	7
	25				
122		22		20	6
	25				
123		21		20	6
	30				
124		25		18	7
	24				
125		29		19	7
	59				
126		19		23	7
	23				
127		57		21	7
	21				
128		117		24	5
	27				
129		130		20	7
	23				
130		158		22	7
	20				
131		67		21	5
132	72			24	6
	37				
133	21			33	5
	37				
134	36			32	5
	40				
135	42			30	7
	39				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
136	48			23	6
	41				
137	38			32	6
	40				
138	15			32	8
	37				
139	27			30	7
	31				
140	47			20	8
	30				
141	49			19	8
	24				
142	76			22	7
	43				
143	22			31	6
	33				
144	98			20	6
	70				
145	14		20		6
	46				
146	14			32	7
	38				
147	16			34	6
	39				
148	20			32	12
	41				
149	13			31	8
	41				
150	24			31	8
	49				
151	22			32	8
	55				
152	18			33	6
	47				
153	21			36	8
	44				
154	25			33	6
	46				
155	32			31	8
		4167			
156	17			14	5
	37				
157	39			35	7
	35				
158	13			32	8
	33				
159	17			32	7
	38				
160	16			35	7
	38				
161	26			24	6
	28				
162	42			26	5
	34				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
163	22			24	6
164	24 36		20		6
165	29 27			24	6
166	26 20			23	8
167	344 82			25	9
168	27 23			23	7
169	26 17			20	7
170	26 24			21	7
171	23 21			21	7
172	36 16			22	7
173	30 15			24	7
174	30 20			20	8
175	46 25			24	7
176	35 24			23	6
177	36 24			23	8
178	39 39			24	5
179	31 13			25	6
180	24 15			25	7
181	24 12			23	8
182	25 12			21	7
183	24 10			24	8
184	23 32			23	6
185	34 43			23	9
186	40 58			29	6
187	25 42			25	8
188	27 17		2228	20	10
189	15 38			21	8

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
190	18			34	8
	39				
191	16			33	11
	52				
192	18			34	7
	38				
193	14			39	5
	40				
194	21			35	7
	60				
195	16			34	7
	58				
196	19			34	5
	47				
197	18			36	5
				183	
198	52			36	6
				206	
199	21			24	5
	41				
200	18			26	5
	31				
201				32	8
	44			387	
202	16			36	5
	81				
203	17			34	6
	79				
204	22			32	8
	80				
205				25	8
	21			211	
206	27			18	9
	26				
207	19			21	6
	34				
208	29			24	5
	40				
209	31			19	9
	34				
210	36			20	6
	30				
211	29			23	7
	33				
212	25			21	8
	39				
213	19			22	8
	41				
214	22			21	7
	46				
215	20			23	9
	48				
216	20			23	11
	37				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
217	22			25	8
	40				
218	24			21	11
	40				
219	23			29	5
			2654		
220	37			21	10
	29				
221	79			25	6
	171				1384
222	31		13		11
	27				
223	16		12		10
	25				
224	61		17		9
	19				
225	54		13		4
	24				
226	52		12		9
	21				
227	55		15		6
	28				
228	7		10		8
	34				
229	11		13		8
	26				
230	20		11		7
	24				
231	46		12		6
	19				
232	39		11		6
	19				
233	10		16		7
	19				
234	18		15		9
	21				
235	91		16		6
	24				
236	9		17		6
	23				
237	8		16		7
	30				
238	11		16		6
	17				
239	10		16		6
	20				
240	23		13		8
	28				
241	20		21		5
	23				
242	56		17		11
	81				
243	11		15		8
	20				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
244	28		17		8
	17				
245	49		15		9
	20				
246	13		13		8
	31				
247	16		16		9
	21				
248	12		17		10
	16				
249	16		15		10
	17				
250	18		17		7
	21				
251	12		14		6
	20				
252	23		15		8
	26				
253	11			17	7
	23				
254	10			16	7
	19				
255	17			15	9
	19				
256	15			16	7
	19				
257	15			15	9
	23				
258	16			20	6
	23				
259	13			15	9
	22				
260	15			18	8
	27				
261	12			19	6
	17				
262	12			17	7
	19				
263	14			17	7
	32				
264	12			18	7
	19				
265	16			18	8
	23				
266	14			19	7
	21				
267	34			18	6
	26				
268	24			16	7
	27				
269	24			21	9
	18				
270	14			21	7
	22				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
271	19				
	25			19	8
272	16				
	22			20	8
273	20				
	23			17	8
274	13				
	20			18	8
275	14				
	27			20	9
276	20				
	37			18	8
277	26				
				17	8
278	15		826		
	16			20	6
279	71				
	21			19	7
280	24			1200	
	15		6		5
281	13				
	63			19	6
282	24				
	30			24	6
283	24				
	31			17	7
284	37				
	33			20	7
285	33				
	25			22	5
286					
	50			8	7
287	25			794	
	31			24	7
288					
	22			25	31
289	50			169	
	20			20	6
290	18				
	15			19	6
291	11				
	24			21	7
292	9				
	21			18	8
293					
	30			21	34
294	29			569	
	32			21	7
295	27				
	36			20	7
296	25				
	36			20	5
297	35				
	44			25	8

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
298	42			21	6
	39				
299				21	7
	36			202	
300	25			21	6
	31				
301	23			22	7
	37				
302	26			21	5
	10				
303	8			16	9
	40				
304	53			21	8
	54				
305	20			20	6
	54				
306	19			24	6
	73				
307	13		20		7
	13				
308	10		23		6
	17				
309	10		19		9
	16				
310	12		18		6
	21				
311	22		14		8
	21				
312	32		21		10
	16				
313	54		12		9
	17				
314	62		14		7
	18				
315	34		33		7
			724		
316	34			9	8
	20				
317	7			24	6
	22				
318	13			26	10
	24				
319	8			19	9
		712			
320	100		14		8
	14				
321	37		16		7
	15				
322	38		15		7
	18				
323	34		17		5
	15				
324	35		17		6
	16				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
325	15		16		7
	22				
326	12		16		6
	14				
327	12		19		6
	18				
328	14		16		7
	22				
329	38			18	6
	20				
330	10			19	7
	20				
331	18			19	6
	17				
332	13			18	6
	20				
333	10			23	6
	23				
334	43			23	6
	29				
335	10			16	6
	22				
336	11			25	6
	19				
337	20			15	10
	16				
338	66			11	6
	22				
339	12			17	7
	22				
340	19			22	6
	38				
341				24	8
	25			454	
342	13			22	7
	28				
343	92			17	7
	24				
344	9			24	6
	21				
345	18			24	6
	28				
346	13			22	8
	21				
347	12			21	7
	25				
348	10			23	8
	18				
349	13			22	5
	27				
350	22			20	10
	23				
351	11			12	5
	27				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
352	127			21	6
	25				
353	17			20	5
	26				
354	24			24	7
	22				
355	10			22	7
	22				
356	16			21	6
	23				
357	10			24	7
	63				
358	10			22	6
	24				
359	11			19	6
	24				
360	15			21	7
	21				
361	15			21	7
	42				
362	30			20	7
	42				
363	24			23	6
	30				
364	32			27	7
	63				
365	36			22	7
	24				
366	38			20	8
	49				
367	81			23	6
	88				
368	44			23	7
	33				
369	24			23	6
	45				
370	12			20	7
	37				
371	17			20	8
	47				
372	20			45	14
	54				
373	18			35	4
	36				
374	33			34	6
	39				
375	42			36	5
	41				
376	18			35	9
	73				
377	16			33	5
	44				
378	16			36	

6502

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
379		15	56		8
	17				
380		10	14		6
	136				
381	14			35	8
	16				
382		20	8		11
	13				
383		33	14		8
	58				
384		25	13		7
	79				
385		24	57		10
	41				
386	13			35	6
	35				
387	12			31	6
	31				
388	11			34	5
		3675			
389	11			37	5
		3021			
390	17			35	6
	37				
391	14			36	5
	41				
392	17			36	6
	41				
393	12			35	5
	39				
394	14			34	7
	43				
395	15			34	6
	39				
396	16			33	6
	37				
397	15			29	6
	38				
398	18			30	7
	38				
399	18			33	5
	57				
400	19			30	4
	32				
401	41			32	31
	55				
402	16			31	6
	44				
403	24			28	5
	39				
404	20			36	4
	50				
405	15			35	5
	38				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
406	17		9		9
	12				
407	13			33	7
	72				
408	10			35	4
	42				
409	103			33	6
	33				
410	11			30	5
	37				
411	9			33	5
	37				
412	8			36	5
	36				
413	94			35	5
	39				
414	15			34	5
	37				
415	12			34	6
	38				
416	12			34	4
	38				
417	17			36	5
	44				
418	20			33	6
	44				
419	17			35	5
	29	178			
420	22			37	8
		779			
421	12			37	4
	40				
422	17			31	6
	38				
423	39			35	5
	44				
424	20			33	7
	47				
425	15			35	4
	44				
426	16			34	6
	44				
427	20			36	5
			167		
428	5			31	6
	38				
429	11			35	5
	39				
430	13			34	6
	53				
431	24			32	4
	44				
432	85			33	4
	39				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
433	24			30	5
	40				
434	23			31	5
	37				
435	11			33	5
	36				
436	12			30	5
	33				
437	12			33	6
	38				
438	11			32	4
	34				
439	12			32	4
	38				
440	8			31	5
	35				
441	14			32	4
	38				
442	100			32	4
	35				
443	13			34	5
	32				
444	10			35	5
	34				
445	14			31	6
	33				
446	15			34	4
	36				
447	13			33	5
	43				
448	27			35	3
	32				
449	12			30	5
450	37			29	5
	42				
451	21			30	5
	41				
452	18			30	4
	36				
453	16			30	6
	31				
454	8			32	5
	41				
455	117			31	6
	150				
456	32			31	5
	34				
457	14			29	8
	36				
458	14			31	6
	42				
459	25			31	5
	37				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
460	93			31	6
	40				
461	12			32	6
	43				
462	18			32	5
	34				
463	15			33	5
	45				
464	22			35	4
	42				
465	14			33	4
	37				
466	10			34	5
	36				
467	15			32	5
	37				
468	12			30	5
	31				
469	15			30	4
	31				
470	13			31	4
	31				
471	12			32	4
	47				
472	28			32	5
	42				
473	31			30	5
		203			
474	26			32	5
	40				
475	35			34	4
	41				
476	39			33	4
	42				
477	30			32	4
	43				
478	43			34	5
	41				
479	51			33	5
	46				
480	27			33	5
	47				
481	30			34	5
	44				
482	43			32	5
	45				
483	22			33	5
	42				
484	28			33	4
	41				
485	50			34	6
			828		
486	39			35	5
	55				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
487	12			33	5
488	48 26			21	5
489	55 10			35	5
490	41 21			34	5
491	44 19			33	6
492	59 18			34	4
493	40 15			32	4
494	49 17			35	7
495	85 20			33	6
496	39 20			33	4
497	48 20			33	5
498	49 24			34	5
499	44 15			33	6
500	52 24			34	6
501	54 21			33	5
502	47 16			36	6
503	157 23			36	9
504	60 14			36	5
505	46 20			36	5
506	45 12			35	4
507	60 16			36	6
508	48 27			33	5
509	51 27			24	6
510	42 12			38	7
511	36 12			37	5
512	39 11			34	6
513	37 34			33 270	7

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
514	115			91	6
	17				
515	11			31	7
	122				
516	9			34	9
				687	
517	45			34	5
	37				
518	33			23	6
	35				
519	11			33	5
	40				
520	17			31	5
	41				
521	17			35	4
	39				
522	10			32	6
	35				
523	8			33	4
	38				
524	30			34	5
	36				
525	12			32	5
	37				
526	12			36	4
	40				
527	7			31	5
	33			267	
528	10			36	5
	66				
529	28			26	3
	78				
530	14			35	5
	39				
531	15			36	6
	41				
532	14			38	4
	97				
533	11			35	4
			1844	2233	
534	13			34	5
	37				
535	15			27	4
	37				
536	15			31	4
	42				
537	13			29	4
	42				
538	12			25	4
	34				
539	18			31	4
	41				
540	11			32	4
	41				

	DAT RETURN	DBT OTHER	S<90 COFFEE	S>90 CLEAN	DUMP WALKING
541	16			30	5
	38				
542	13			28	5
	41				
543	12		13		3
	19				
544	15		8		5
	13				
545	12		13		7
	18				
546	12		10		7
	20				
547	20		8		6
	36				
548	12		13		6
	24				
549	17		12		6
	30				
550	20		9		7
	27				
551	21			34	5
	105				
552	16			36	4
	44				
553	17			32	5
	53				
554	18			31	5
	45				
555	16			30	5
	35				
556	8			02	5
	42				
557	16			32	4
	35				
558	14			33	4
	30				
559	12			35	4
	46				
560	17			31	4
	39				
561	12			32	5
	41				
562	16			33	4
	50				
563	15			33	4
	37				
564	10			32	5
	38				
565	61			26	7
	36				
566	27			27	7
	34				
567	25			31	4
	42				

	DAT RETURN	DBT OTHER	S:90 COFFEE	S:90 CLEAN	DUMP WALKING
568	19			26	7
	45				
569	18			26	7
570	16			28	4
			690		
571	19			36	5
	33				
572	25			33	5
	39				
573	21			30	5
	43				
574	36			30	4
	44				
575	22			29	4
	52				
576	19			31	4
	56				
577	23			29	4
	36				
578	22			31	4
	48				
579	20			32	4
	49				
580	23			28	4
	37				
581	21			20	4
	42				
582	20			28	4
	36				
583	43			33	4
	37				
584	21			28	4
	36				
585	23			28	5
	40				
586	25			29	4
	34				
587	26			26	4
	40				
588	47			27	6
	32				
589	43			30	5
	30				
590	27			17	5
	30				
591	19			29	5
	32				
592	24			33	5
	37				
593	23			26	5
	35				
594	23			28	4
	34				

	DAT RETURN	DBT OTHER	S:90 COFFEE	S:90 CLEAN	DUMP WAITING
				34	5
595	20				
	30			25	6
596	49				
	42	1807		26	5
597	21				
	31			26	7
598	47				
	42			31	5
599	15				
	39				

LISTING COMPLETED

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXXXX
MEAN= 22.0710059172      VARIANCE= 101.721118625 STAND DEV= 10.08568830
# OF DATA SETS PRESENT= 169 OUT OF 282

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 282

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXXXX
MEAN= 15.4082840237      VARIANCE= 14.5882643 STAND DEV= 3.81945863968
# OF DATA SETS PRESENT= 169 OUT OF 282

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 282

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXXXX
MEAN= 7.16568047337      VARIANCE= 2.59143423685 STAND DEV= 1.609792218
# OF DATA SETS PRESENT= 169 OUT OF 282

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXXXX
MEAN= 24.0843373494      VARIANCE= 25.8110253212 STAND DEV= 5.080455286
# OF DATA SETS PRESENT= 166 OUT OF 282

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXXXX
MEAN= 131      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 282

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXXXX
MEAN= 1713.5      VARIANCE= 953530.5 STAND DEV= 976.514464816
# OF DATA SETS PRESENT= 2 OUT OF 282

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 282

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 282
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXXXX
MEAN= 29.2807017544      VARIANCE= 345.812656643 STAND DEV= 18.59603873
# OF DATA SETS PRESENT= 57 OUT OF 188

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXXX
MEAN= 58.6153846154      VARIANCE= 2438.25641026 STAND DEV= 49.37870401
# OF DATA SETS PRESENT= 13 OUT OF 188

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXXX
MEAN= 20      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 2 OUT OF 188

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXXX
MEAN= 25.25      VARIANCE= 28.2500000015 STAND DEV= 5.31507290644
# OF DATA SETS PRESENT= 68 OUT OF 188

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXXX
MEAN= 6.97142857143      VARIANCE= 1.62236024855 STAND DEV= 1.2737190618
# OF DATA SETS PRESENT= 70 OUT OF 188

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXXX
MEAN= 38.4848484848      VARIANCE= 1551.23822945 STAND DEV= 39.385761748
# OF DATA SETS PRESENT= 66 OUT OF 188

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXXX
MEAN= 2246.5      VARIANCE= 7376640.5 STAND DEV= 2715.99714658
# OF DATA SETS PRESENT= 2 OUT OF 188

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXXX
MEAN= 2228      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 188

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 188

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 188
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXX
MEAN= 20.68      VARIANCE= 310.752653061 STAND DEV= 17.6281778143
# OF DATA SETS PRESENT= 50 OUT OF 427

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXX
MEAN= 21.1666666667      VARIANCE= 65.366666666 STAND DEV= 8.0849654706
# OF DATA SETS PRESENT= 6 OUT OF 427

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXX
MEAN= 24.4285714286      VARIANCE= 485.61904762 STAND DEV= 22.036765815
# OF DATA SETS PRESENT= 7 OUT OF 427

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXX
MEAN= 34.1224489796      VARIANCE= 7.06802721042 STAND DEV= 2.6585761621
# OF DATA SETS PRESENT= 49 OUT OF 427

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXX
MEAN= 6.52727272727      VARIANCE= 14.8094276094 STAND DEV= 3.8483019124
# OF DATA SETS PRESENT= 55 OUT OF 427

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXX
MEAN= 42.6666666667      VARIANCE= 337.26666666 STAND DEV= 18.3648214439
# OF DATA SETS PRESENT= 51 OUT OF 427

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXX
MEAN= 2831      VARIANCE= 6363447.5 STAND DEV= 2523.57831258
# OF DATA SETS PRESENT= 5 OUT OF 427

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXX
MEAN= 167      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 427

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 427

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 427
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXX
MEAN= 21.6524390244      VARIANCE= 82.927540027 STAND DEV= 9.1064559532
# OF DATA SETS PRESENT= 164 OUT OF 446

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 446

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXX
MEAN= 16.6768292683      VARIANCE= 15.913324854 STAND DEV= 3.98915089382
# OF DATA SETS PRESENT= 164 OUT OF 446

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 446

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXX
MEAN= 6.44512195122      VARIANCE= 2.49390243902 STAND DEV= 1.5792094349
# OF DATA SETS PRESENT= 164 OUT OF 446

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXX
MEAN= 26.875      VARIANCE= 28.2106918239 STAND DEV= 5.31137381684
# OF DATA SETS PRESENT= 160 OUT OF 446

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXX
MEAN= 675      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 446

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXX
MEAN= 936      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 446

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 446

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 446
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXX
MEAN= 23.275862069      VARIANCE= 235.760224537 STAND DEV= 15.3544854e54
# OF DATA SETS PRESENT= 87 OUT OF 277

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 277

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXX
MEAN= 14.7096774194      VARIANCE= 5.612903226 STAND DEV= 2.36915664862
# OF DATA SETS PRESENT= 31 OUT OF 277

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXX
MEAN= 23.2068965517      VARIANCE= 46.6231095 STAND DEV= 6.82811170792
# OF DATA SETS PRESENT= 58 OUT OF 277

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXX
MEAN= 7.49438202247      VARIANCE= 2.61644535227 STAND DEV= 1.6175423985
# OF DATA SETS PRESENT= 89 OUT OF 277

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXX
MEAN= 32.3647058824      VARIANCE= 449.139215679 STAND DEV= 21.192904843
# OF DATA SETS PRESENT= 85 OUT OF 277

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 277

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXX
MEAN= 1740      VARIANCE= 1670792 STAND DEV= 1292.591196
# OF DATA SETS PRESENT= 2 OUT OF 277

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXX
MEAN= 246.75      VARIANCE= 8890.91666667 STAND DEV= 94.2916574584
# OF DATA SETS PRESENT= 4 OUT OF 277

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXX
MEAN= 1384      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 277
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXXXX
MEAN= 23.5333333333      VARIANCE= 412.94358974 STAND DEV= 20.3210135002
# OF DATA SETS PRESENT= 105 OUT OF 532

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 532

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 532

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXXXX
MEAN= 33.1523809524      VARIANCE= 39.5342490965 STAND DEV= 6.2876266655
# OF DATA SETS PRESENT= 105 OUT OF 532

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXXXX
MEAN= 5.11428571429      VARIANCE= 1.06373626375 STAND DEV= 1.0313759080
# OF DATA SETS PRESENT= 105 OUT OF 532

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXXXX
MEAN= 45.46      VARIANCE= 419.341818182 STAND DEV= 20.4778372435
# OF DATA SETS PRESENT= 100 OUT OF 532

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXXXX
MEAN= 203      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 532

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXXXX
MEAN= 828      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 532

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXXXX
MEAN= 408      VARIANCE= 58383 STAND DEV= 241.625743658
# OF DATA SETS PRESENT= 3 OUT OF 532

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 532
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXXX
MEAN= 22.2935779817      VARIANCE= 127.616717635 STAND DEV= 11.29675695
# OF DATA SETS PRESENT= 109 OUT OF 113

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXX
MEAN= 19.25      VARIANCE= 149.583333333 STAND DEV= 12.2304265391
# OF DATA SETS PRESENT= 4 OUT OF 113

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXXX
MEAN= 12.5862068966      VARIANCE= 9.89594676386 STAND DEV= 3.145782377
# OF DATA SETS PRESENT= 58 OUT OF 113

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXXX
MEAN= 18.5818181818      VARIANCE= 70.2478114481 STAND DEV= 8.381396748
# OF DATA SETS PRESENT= 55 OUT OF 113

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXXX
MEAN= 6.59292035398      VARIANCE= 20.7435208597 STAND DEV= 4.5545055558
# OF DATA SETS PRESENT= 113 OUT OF 113

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXX
MEAN= 28.6574074074      VARIANCE= 219.498355832 STAND DEV= 14.815476902
# OF DATA SETS PRESENT= 108 OUT OF 113

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXX
MEAN= 15418.5      VARIANCE= 468884064.5 STAND DEV= 21653.7309604
# OF DATA SETS PRESENT= 2 OUT OF 113

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXX
MEAN= 626      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 113

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXX
MEAN= 651.5      VARIANCE= 233244.5 STAND DEV= 482.953931528
# OF DATA SETS PRESENT= 2 OUT OF 113

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXX
MEAN= 997      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 113
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXXXX
MEAN= 26.6292134831      VARIANCE= 461.895045966 STAND DEV= 21.491743668
# OF DATA SETS PRESENT= 89 OUT OF 371

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 371

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXXXX
MEAN= 17.1578947368      VARIANCE= 28.1403508772 STAND DEV= 5.3047473560
# OF DATA SETS PRESENT= 19 OUT OF 371

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXXXX
MEAN= 20.5466666667      VARIANCE= 12.2511711716 STAND DEV= 3.5001673062
# OF DATA SETS PRESENT= 75 OUT OF 371

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXXXX
MEAN= 7.05106382979      VARIANCE= 15.2840311144 STAND DEV= 3.9094796474
# OF DATA SETS PRESENT= 94 OUT OF 371

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXXXX
MEAN= 28.6195652174      VARIANCE= 218.084448159 STAND DEV= 14.767682559
# OF DATA SETS PRESENT= 92 OUT OF 371

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXXXX
MEAN= 712      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 371

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXXXX
MEAN= 724      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 371

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXXXX
MEAN= 564.666666667      VARIANCE= 151317.466666 STAND DEV= 388.99545940
# OF DATA SETS PRESENT= 6 OUT OF 371

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 371
```

```
FOR COLUMN NO. 1
XXXXXXXXXXXXXXXXXXX
MEAN= 20.8656716418      VARIANCE= 103.451379467 STAND DEV= 10.171105124
# OF DATA SETS PRESENT= 67 OUT OF 599

FOR COLUMN NO. 2
XXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 599

FOR COLUMN NO. 3
XXXXXXXXXXXXXXXXXXX
MEAN= 10.75      VARIANCE= 5.07142857143 STAND DEV= 2.25198325288
# OF DATA SETS PRESENT= 8 OUT OF 599

FOR COLUMN NO. 4
XXXXXXXXXXXXXXXXXXX
MEAN= 29.7966101695      VARIANCE= 13.0613676207 STAND DEV= 3.6140514135
# OF DATA SETS PRESENT= 59 OUT OF 599

FOR COLUMN NO. 5
XXXXXXXXXXXXXXXXXXX
MEAN= 4.83582089552      VARIANCE= 1.04839439167 STAND DEV= 1.0239113202
# OF DATA SETS PRESENT= 67 OUT OF 599

FOR COLUMN NO. 6
XXXXXXXXXXXXXXXXXXX
MEAN= 38.375      VARIANCE= 136.174603175 STAND DEV= 11.6693874377
# OF DATA SETS PRESENT= 64 OUT OF 599

FOR COLUMN NO. 7
XXXXXXXXXXXXXXXXXXX
MEAN= 1807      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 599

FOR COLUMN NO. 8
XXXXXXXXXXXXXXXXXXX
MEAN= 1271      VARIANCE= 656658 STAND DEV= 810.344371176
# OF DATA SETS PRESENT= 2 OUT OF 599

FOR COLUMN NO. 9
XXXXXXXXXXXXXXXXXXX
MEAN= 2233      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 1 OUT OF 599

FOR COLUMN NO. 10
XXXXXXXXXXXXXXXXXXX
MEAN= 0      VARIANCE= 0 STAND DEV= 0
# OF DATA SETS PRESENT= 0 OUT OF 599
```

APPENDIX B: SECOND FIELD WORK DATA FILES

Offscale large swings :angle,duration,time.

200	27.97000	2120.000
200	27.45000	2121.000
200	28.42000	2123.000
200	27.90000	2124.000
200	26.73000	2125.000
200	26.80000	2127.000
200	26.28000	2128.000
200	27.86000	2130.000
200	25.04000	2131.000
200	24.87000	2134.000
200	23.11000	2136.000
200	27.11000	2137.000
200	26.47000	2138.000
200	26.42000	2140.000
200	26.39000	2141.000
200	23.43000	2143.000
200	26.80000	2148.000
200	31.95000	2150.000
200	28.09000	2212.000
200	29.31000	2214.000
200	26.79000	2215.000
200	25.98000	2216.000
200	24.65000	2218.000
200	28.41000	2220.000
200	28.79000	2222.000
200	26.17000	2223.000
200	25.99000	2225.000
200	28.26000	2226.000
200	31.67000	2230.000
200	29.68000	2231.000
200	26.71000	2233.000
200	28.27000	2234.000
200	26.21000	2235.000
200	27.38000	2237.000
200	25.73000	2238.000
200	28.22000	2240.000
200	27.14000	2241.000
200	27.44000	2243.000
200	27.08000	2244.000
200	28.79000	2247.000
200	27.60000	2249.000
200	25.71000	2250.000
200	25.24000	2251.000
200	25.16000	2253.000
200	25.31000	2254.000
200	27.04000	2256.000
200	27.84000	2257.000
200	27.58000	2259.000
200	27.44000	2300.000
200	27.91000	2321.000

200	26.86000	2325.000
200	29.14000	2327.000
200	27.47000	2328.000
200	29.06000	2330.000
200	29.50000	2331.000
200	27.08000	2333.000
200	31.47000	2336.000
200	27.67000	2341.000
200	27.[illegible]7000	2342.000
200	28.03000	2344.000
200	27.07000	2345.000
200	27.83000	2347.000
200	24.49000	1925.000
200	26.52000	1927.000
200	27.61000	1928.000
200	27.13000	1936.000
200	24.51000	1937.000
200	27.01000	1939.000
320	47.81000	2330.000
320	48.73000	2333.000
320	46.54000	2335.000
320	45.30000	2336.000
320	46.57000	2338.000
320	45.93000	2340.000
320	45.84000	2342.000
320	45.73000	2345.000
320	44.20000	2347.000

Offscale	short swings	angle, duration, time.
35	15.55000	2220.000
35	6.220000	2221.000
35	11.52000	2222.000
35	20.25000	2223.000
35	17.70000	2224.000
35	18.23000	2225.000
35	24.78000	2226.000
35	14.59000	2227.000
35	15.12000	2228.000
35	15.79000	2229.000
35	18.12000	2230.000
35	17.15000	2230.000
35	19.20000	2231.000
35	12.37000	2234.000
35	14.64000	2235.000
35	15.74000	2237.000
35	17.03000	2238.000
35	14.83000	2240.000
35	13.18000	2242.000
35	21.11000	2243.000
35	13.19000	2246.000
35	14.40000	2248.000
35	16.46000	2249.000
35	16.54000	2250.000
35	20.01000	2251.000
35	10.99000	2252.000
35	18.92000	2254.000
35	17.10000	2255.000
35	18.08000	2256.000
35	17.45000	2257.000
35	17.54000	2258.000
35	17.19000	2259.000
35	15.63000	2318.000
35	15.80000	2319.000
35	13.85000	2319.000
35	16.91000	2320.000
35	16.96000	2352.000
35	9.020000	2354.000
35	18.01000	2355.000
35	16.87000	2356.000
35	14.82000	2356.000
35	16.25000	2357.000
35	13.66000	2358.000
35	15.14000	2359.000
35	14.82000	1.000000
35	15.57000	4.000000
35	16.55000	5.000000
35	14.23000	6.000000

35	16.16000	7.000000
35	20.26000	25.00000
35	17.55000	26.00000
35	20.10000	28.00000
35	16.99000	29.00000
35	17.00000	30.00000
35	15.27000	31.00000
35	12.65000	32.00000
35	14.81000	33.00000
35	16.82000	34.00000
35	17.17000	35.00000
35	14.43000	36.00000
35	13.88000	37.00000
35	15.80000	38.00000
35	16.73000	39.00000
35	15.59000	39.00000
35	13.33000	40.00000
35	13.42000	41.00000
35	16.13000	42.00000
35	14.51000	43.00000
35	15.86000	44.00000
35	18.00000	45.00000
35	16.67000	46.00000
35	17.03000	47.00000
35	14.93000	48.00000
45	13.71000	54.00000
45	17.31000	55.00000
45	18.65000	56.00000
45	17.43000	57.00000
45	17.80000	58.00000
45	15.34000	59.00000
50	18.87000	224.0000
55	17.46000	225.0000
55	17.27000	226.0000
55	18.72000	227.0000
55	18.50000	228.0000
55	15.63000	230.0000
55	19.44000	232.0000
55	16.15000	242.0000
55	18.49000	243.0000
55	17.30000	244.0000
55	18.95000	245.0000
55	18.65000	247.0000
55	17.70000	247.0000
55	18.60000	248.0000
55	17.19000	249.0000
55	19.57000	250.0000
55	18.48000	252.0000
55	17.27000	253.0000
55	18.27000	254.0000
55	18.41000	256.0000
55	20.09000	257.0000
55	18.35000	258.0000
55	19.85000	259.0000

Offscale large swings :angle,duration,time.

240	32.90000	724.0000
240	29.13000	728.0000
240	27.76000	729.0000
240	38.74000	731.0000
240	32.71000	732.0000
240	29.60000	734.0000
240	23.53000	736.0000
240	27.18000	738.0000
240	23.96000	739.0000
240	28.44000	740.0000
240	27.88000	742.0000
240	30.67000	743.0000
240	27.42000	746.0000
240	28.33000	747.0000
240	27.61000	750.0000
240	28.43000	751.0000
240	30.22000	753.0000
240	27.23000	808.0000
240	30.00000	810.0000
240	28.52000	811.0000
240	24.73000	814.0000
240	30.45000	819.0000
240	25.49000	821.0000
240	29.99000	822.0000
240	28.63000	911.0000
240	28.28000	912.0000
240	28.93000	915.0000
240	26.08000	916.0000
240	26.23000	917.0000
240	29.81000	919.0000
240	31.43000	1201.000
240	32.69000	1203.000
240	27.34000	1208.000
240	30.06000	1209.000
240	31.59000	1320.000
240	28.59000	1322.000
240	29.49000	1324.000
240	31.77000	1325.000
240	28.80000	1326.000
240	31.28000	1328.000
240	28.41000	1329.000
240	30.15000	1331.000
240	31.29000	1332.000
240	31.85000	1334.000
240	31.70000	1336.000
240	29.35000	1337.000
240	30.99000	1339.000

Offscale	large swings	:angle,duration,time.
200	29.03000	726.0000
200	30.20000	728.0000
200	27.78000	729.0000
200	26.84000	730.0000
200	22.26000	733.0000
200	28.08000	735.0000
200	27.74000	736.0000
200	27.01000	737.0000
200	24.88000	739.0000
200	25.08000	740.0000
200	29.55000	742.0000
200	31.11000	745.0000
200	24.46000	746.0000
200	27.58000	747.0000
200	28.75000	749.0000
200	28.15000	750.0000
200	29.33000	751.0000
200	31.56000	753.0000
200	30.07000	755.0000
200	30.69000	756.0000
200	26.58000	757.0000
200	32.80000	759.0000
200	33.43000	800.0000
200	29.01000	802.0000
200	30.76000	803.0000
200	33.80000	807.0000
200	30.39000	809.0000
200	30.72000	810.0000
200	30.83000	812.0000
200	30.90000	813.0000
200	32.75000	815.0000
200	32.77000	816.0000
200	29.60000	818.0000
200	29.49000	819.0000
200	31.95000	821.0000
200	31.25000	822.0000
200	29.52000	824.0000
200	31.08000	826.0000
200	26.51000	827.0000
200	28.81000	829.0000
200	26.68000	830.0000
200	28.60000	832.0000
200	24.60000	833.0000
200	28.96000	834.0000
200	35.58000	836.0000
200	30.83000	837.0000
200	28.91000	839.0000
200	28.42000	841.0000

200	30.47000	842.0000
200	28.01000	844.0000
200	29.86000	845.0000
200	33.41000	847.0000
200	29.16000	850.0000
200	30.48000	851.0000
200	38.63000	853.0000
200	31.72000	854.0000
200	31.79000	856.0000
200	35.33000	858.0000
200	33.25000	859.0000
200	31.60000	901.0000
200	30.35000	902.0000
200	29.94000	904.0000
200	33.40000	905.0000
200	28.92000	907.0000
220	26.34000	921.0000
220	24.99000	922.0000
220	27.91000	924.0000
220	32.85000	925.0000
220	31.18000	927.0000
220	30.16000	928.0000
220	32.26000	932.0000
220	30.17000	933.0000
220	32.01000	940.0000
220	34.18000	943.0000
220	28.45000	944.0000
220	29.22000	946.0000
220	33.10000	947.0000
220	30.15000	949.0000
220	29.28000	950.0000
220	31.45000	952.0000
220	28.83000	953.0000
220	27.87000	954.0000
220	31.84000	956.0000
220	29.21000	957.0000
220	26.73000	1000.000
220	32.45000	1002.000
220	30.74000	1004.000
220	34.09000	1005.000
220	31.73000	1009.000
220	32.98000	1010.000
220	29.47000	1012.000
220	27.47000	1020.000
220	32.34000	1026.000
220	31.21000	1028.000
220	34.39000	1029.000
220	24.65000	1031.000
220	28.64000	1036.000
220	27.79000	1038.000
220	32.57000	1040.000
220	29.44000	1045.000

APPENDIX C: HISTOGRAMS DATA

```
$ R CLASS
ENTER THE NAME OF DATA FILE
CD1360.DAT
number of cycles          490

          1          0to          5          0
          2          5to         10          0
          3         10to         15          0
          4         15to         20          0
          5         20to         25          0
          6         25to         30          0
          7         30to         35          0
          8         35to         40          0
          9         40to         45          1
         10         45to         50          6
         11         50to         55         17
         12         55to         60         26
         13         60to         65         77
         14         65to         70         67
         15         70to         75         54
         16         75to         80         48
         17         80to         85         59
         18         85to         90         47
         19         90to         95         39
         20         95to        100         16
         21        100to        105          5
         22        105to        110          5
         23        110to        115          1
         24        115to        120          2
         25        120to        125          0
         26        125to        130          0
         27        130to        135          0
         28        135to        140          0
         29        140to        145          0
         30        145to        150          0
         31        150to        155          0
         32        155to        160          0
         33        160to        165          0
         34        165to        170          0
         35        170to        175          0
         36        175to        180          0
         37        180to        185          0
         38        185to        190          0
         39        190to        195          0
         40        195to        200          0
         41        200to        205          0
END TIME OF FIRST CYCLE=1620. END TIME OF LAST CYCLE=1248.
 MEAN= 75.00 STANDARD DEVIATION= 12.91
NO OF SECONDS OF ACTIVITY IN FILE IS    36750.53
```

```
$ R CLASS
ENTER THE NAME OF DATA FILE
CN1360.DAT
number of cycles          248

          1          0to          5          0
          2          5to         10          0
          3         10to         15          0
          4         15to         20          0
          5         20to         25          0
          6         25to         30          0
          7         30to         35          0
          8         35to         40          0
          9         40to         45          0
         10         45to         50          0
         11         50to         55          0
         12         55to         60          3
         13         60to         65          8
         14         65to         70         42
         15         70to         75         57
         16         75to         80         45
         17         80to         85         34
         18         85to         90         36
         19         90to         95         11
         20         95to        100          4
         21        100to        105          6
         22        105to        110          0
         23        110to        115          0
         24        115to        120          2
         25        120to        125          0
         26        125to        130          0
         27        130to        135          0
         28        135to        140          0
         29        140to        145          0
         30        145to        150          0
         31        150to        155          0
         32        155to        160          0
         33        160to        165          0
         34        165to        170          0
         35        170to        175          0
         36        175to        180          0
         37        180to        185          0
         38        185to        190          0
         39        190to        195          0
         40        195to        200          0
         41        200to        205          0
END TIME OF FIRST CYCLE=2118. END TIME OF LAST CYCLE=2130.
 MEAN= 78.07 STANDARD DEVIATION=  9.61
NO OF SECONDS OF ACTIVITY IN FILE IS    19360.83
```

```
$ R CLASS
ENTER THE NAME OF DATA FILE
CD8050.DAT
number of cycles          244

          1          0to          5          0
          2          5to         10          0
          3         10to         15          0
          4         15to         20          0
          5         20to         25          0
          6         25to         30          0
          7         30to         35          0
          8         35to         40          0
          9         40to         45          4
         10         45to         50         23
         11         50to         55         44
         12         55to         60         52
         13         60to         65         22
         14         65to         70          9
         15         70to         75         14
         16         75to         80         10
         17         80to         85         23
         18         85to         90          9
         19         90to         95          6
         20         95to        100          4
         21        100to        105          1
         22        105to        110          1
         23        110to        115          0
         24        115to        120          2
         25        120to        125          0
         26        125to        130          0
         27        130to        135          0
         28        135to        140          0
         29        140to        145          0
         30        145to        150          0
         31        150to        155          0
         32        155to        160          0
         33        160to        165          0
         34        165to        170          0
         35        170to        175          0
         36        175to        180          0
         37        180to        185          0
         38        185to        190          0
         39        190to        195          0
         40        195to        200          0
         41        200to        205          0
END TIME OF FIRST CYCLE=1023. END TIME OF LAST CYCLE=1413.
 MEAN= 63.16 STANDARD DEVIATION= 14.85
NO OF SECONDS OF ACTIVITY IN FILE IS    15410.98
```

```
$ R CLASS
ENTER THE NAME OF DATA FILE
CN8050.DAT
number of cycles          294

     1          0to          5          0
     2          5to         10          0
     3         10to         15          0
     4         15to         20          0
     5         20to         25          0
     6         25to         30          0
     7         30to         35          0
     8         35to         40          0
     9         40to         45          2
    10         45to         50         18
    11         50to         55         56
    12         55to         60         77
    13         60to         65         58
    14         65to         70         36
    15         70to         75         17
    16         75to         80          9
    17         80to         85          3
    18         85to         90          2
    19         90to         95          2
    20         95to        100          1
    21        100to        105          3
    22        105to        110          1
    23        110to        115          3
    24        115to        120          5
    25        120to        125          1
    26        125to        130          1
    27        130to        135          0
    28        135to        140          0
    29        140to        145          0
    30        145to        150          0
    31        150to        155          0
    32        155to        160          0
    33        160to        165          0
    34        165to        170          0
    35        170to        175          0
    36        175to        180          0
    37        180to        185          0
    38        185to        190          0
    39        190to        195          0
    40        195to        200          0
    41        200to        205          0
END TIME OF FIRST CYCLE=2220. END TIME OF LAST CYCLE=2232.
 MEAN= 62.94 STANDARD DEVIATION= 14.33
NO OF SECONDS OF ACTIVITY IN FILE IS    18504.08
```

POOR
QUALITY
ORIGINAL